FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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March, 1957 Volume 11, Number 3

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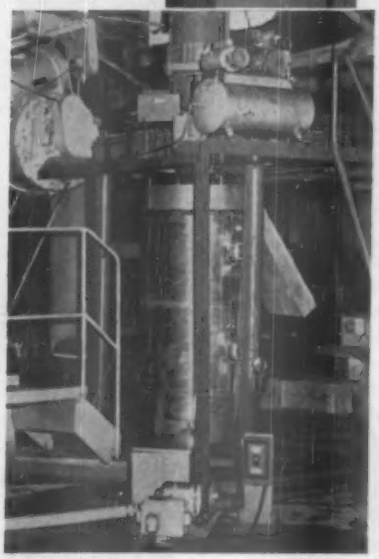

View of prototype FMC Vertical Screw Press installed at Bercut-Richards Packing Co., Sacramento. Tested and used in actual production runs during the 1955 tomato season, the additional juice recovery and reduced cost of wet waste disposal saved cost of equipment in about half a season.

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FEATURING THIS MONTH . . .

The Laboratories of the Wisconsin Alumni Research Foundation

Lester J. Teply
Wisconsin Alumni Research Foundation, Madison

FROM A MODEST START 27 years ago as a facility for checking the vitamin D potency of products produced under license from the Wisconsin Alumni Research Foundation, the WARF laboratories have grown so that they now engage a full time staff of some 50 scientists and technicians in providing testing and consulting services in various fields. A brief description of the development and present activities of the laboratories and their relationship to the WARF follows.

Founded on $900 from 9 "alums." The Foundation itself was organized as a not-for-private-profit corporation in 1925 by nine University of Wisconsin alumni, each of whom contributed one hundred dollars to provide a starting capital fund. It was set up to provide a mechanism for accepting assignment of patents such as the Steenbock vitamin D irradiation patents (which actually sparked the formation of WARF) and administering them in such a way that the interests of the public would be protected. Funds obtained through royalties were to be used for the support of research at the University of Wisconsin in accord with the avowed purpose "to promote, encourage and aid scientific investigation and research at the University." The Foundation is an organization separate and distinct from the University and is governed by a board of trustees made up of alumni of the University. None of the trustees is a member of the University faculty or staff. WARF was a pioneer in that it was the first private organization formed primarily to handle patent matters for those staff members of a state-controlled institution who might choose to assign patent rights. Income from the vitamin D patents and a number of others assigned to the Foundation during the past thirty years has made possible substantial annual grants to the University.

In consideration of the need for protecting the public interest with respect to assurance of proper vitamin D potency in products produced under license from WARF, a laboratory was established in 1930 for the purpose of periodically checking the vitamin D potency of licensees' products by bioassay. This was done at the Foundation's expense. It was not long before the Foundation began to receive requests for additional laboratory services. Over a period of years a program of testing and consulting services was evolved primarily in response to these requests; eventually these services were formally offered to industry on a fee basis.

Vitamin D assay with rats continues to be one of the major activities of the Foundation laboratories. Currently some 35,000 rats are used by WARF each year in checking the vitamin D potency of pharmaceuticals, milk products and miscellaneous samples. Milks are submitted for periodic tests from all parts of the country and in this work there is close cooperation with the regulatory agencies in these areas.

In view of the history of the Foundation it is not surprising that much of the testing and consulting work of its laboratories has been in the field of biochemistry—with emphasis on foods and nutrition. Complete food analysis is available, including proximate analysis, mineral determination and vitamin and amino acid assay. Because of the variety of samples submitted to the laboratory the staff must keep up to date on the latest improvements in assay methods and it constantly carries out research on methodology.

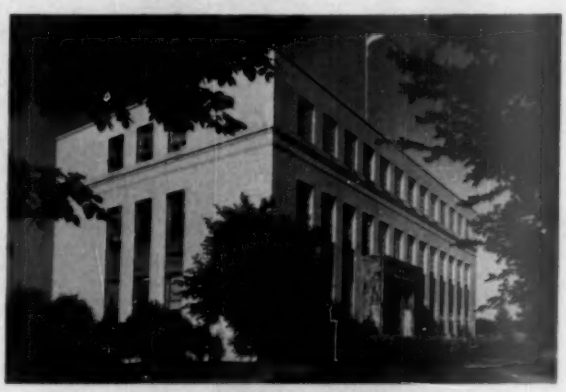

Figure 1. The main building.

A staff of chemists is available for special investigations in their field and bacteriological services, including fungicide screening, are offered.

Expansion into new fields. The development of the insecticide testing division is an example of the expansion of the laboratories in response to requests for services in a particular area. As the pesticide market grew there was increasing demand for insecticide bioassay services in an independent laboratory. WARF set up the necessary facilities and employed an expert staff to provide these services. The venture turned out to be successful and currently a staff is kept active in carrying out insecticide screening tests and checking potency of formulated products. Certain insecticide residues are determined by bioassay and in some cases the analytical chemistry laboratory performs concurrent chemical tests for the same residues.

The most rapidly expanding section of the laboratories in recent years has been the one concerned with experimental animal studies. In addition to vitamin D rat assays, other biological vitamin assays are performed, including vitamin D_3 assay with the chick. A great deal of work is done on the evaluation of animal feed ingredients and food products by animal feeding tests. The feed industry has long recognized the im-

(Continued on page 4)

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(Continued from page 2)

portance of such tests and recently there has been increasing application of them in the evaluation of products by the food industries. Toxicity testing is also an important part of the animal work. Increasing use of pesticides and food additives combined with the testing requirements of regulatory agencies has brought

Figure 2. Part of insecticide testing laboratory.

about a sharply increased demand for this type of work. Both short-term and long-term tests (including tests for carcinogenicity) are carried out with various species.

Approximately one year ago the Foundation laboratories expanded their food technology facilities and since then trained panel flavor evaluation services have been offered. Some family panel flavor evaluation work is also done particularly as an adjunct to laboratory formulation work on certain products. Currently considerable testing is being carried out on the relationship of packaging materials to stability of packaged food products during storage.

In recent years the laboratories have carried out more and more long term investigations for industry and government. To cite a few examples, about one year ago the results of a comprehensive survey of the nutrient values in commercially processed frozen foods were published. This work was sponsored by the National Association of Frozen Food Packers. Survey work along similar lines has also been conducted for the National Canners Association—Can Manufacturers Institute. At present the Foundation is one of several U. S. Public Health Service contractors carrying out large scale screening of compounds for therapeutic effects against mouse tumors. Testing of radiation preserved foods is being performed for the Department of the Army.

Expansion of its program rendered the original quarters of the Foundation inadequate; in 1947 a new building was constructed on the Foundation's own grounds at the west edge of the University of Wisconsin campus (Figure 1). Within 6 years the laboratory had again outgrown its facilities and a structure was built to house the insecticide testing laboratory and the experimental animals (except for rats used in vitamin D assay).

Fifteen million dollars to the University of Wisconsin! Any income derived from the laboratory operation is added to the general fund from which grants are made to the University of Wisconsin. Currently the annual grant exceeds one-million dollars and the total amount which has been given in the form of grants for research, fellowships and special gifts is in excess of fifteen million dollars. Grants for the support of research are made with "no strings attached"—there is no obligation to assign to WARF any patent rights which may develop from research supported by these funds. The funds are administered by the Research Committee of the Graduate School, University of Wisconsin, with the Foundation retaining no control whatsoever.

Although the Foundation is a not-for-private-profit organization, federal income taxes are paid on certain of its operations including the laboratory operation.

Over the years a number of patents have been assigned to the Foundation and an active Licensing and Development Division is maintained. Many of the patents have been in the field of food technology. One of the earlier patents (Hart, Clifcorn and Griem) covered a method for stabilizing iodine in iodized salt. Some more recent patents have dealt with special cheeses, V-10 protein concentrate for food fortification and Cransweets. The latter is a cranberry product produced by a process allowing retention of the rounded form in the processed berry by evacuation of the air sacs and allowing a sugar solution to fill back in. This is a development from the laboratory of Prof. K. G. Weckel, University of Wisconsin food technologist. One of the most successful patent developments of the Foundation has been the anticoagulant rodenticide, warfarin, from the laboratories of Prof. K. P. Link, University of Wisconsin biochemist. The WARF laboratories are utilized as required in the development of some of these patents and control of the products produced under license.

Figure 3. Blending equipment in vitamins concentrate plant.

Vitamin D concentrates. Another WARF operation of interest to food technologists is the production of vitamin D concentrates and certain other vitamin and mineral concentrates for the dairy industry. After the mid-1930's there was a gradual shift from direct irradiation of fluid and evaporated milks to direct fortification with concentrates. Today essentially all of the vitamin D fortification of fluid and evaporated milks is done by the direct addition method. Ordinary oil preparations

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FOOD TECHNOLOGY

Published Monthly by the Institute of Food Technologists

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Subscription Rates: For members the cost of subscription is included in the annual dues. Non-members: domestic, $8.50 per year; Canada, Cuba and Mexico, $10.00 per year; all other foreign, $12.00 per year. Single and back copies: domestic, $1.50; foreign, $1.75.

Advertising Representatives: *Eastern:* Duncan Macpherson, 126 Summit Avenue, Jenkintown, Pa. *Midwestern:* Dale McCutcheon & Co., 154 E. Erie Street, Chicago 11, Illinois. *West Coast:* William A. Ayres Company, 233 Sansome Street, San Francisco 4, California.

Publication Office

The Garrard Press

119 West Park Avenue, Champaign, Illinois

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FOOD TECHNOLOGY is published by the Institute of Food Technologists and printed by the Garrard Press, Champaign, Illinois, U. S. A.

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(Continued from page 4)

carrying vitamin D are not suitable and convenient for the fortification of milk. Beginning in 1937 the Foundation made its technical services available to the dairy industry in the processing of convenient homogenized, canned, sterilized vitamin D concentrates in milk carriers. Since 1947 the Foundation has been processing such concentrates in its own plant on the Foundation grounds. Availability of the laboratory staff and facilities, particularly with respect to bacteriology and vitamin D bioassay, facilitates careful control of all phases of this opertion—i.e., control of the primary vitamin D, the concentrates, and the fortified food products.

As might be expected, the laboratories of the Foundation have received many visitors over the years. Last fall a delegation of IFT members from the Chicago and surrounding area toured the laboratories. Year in and year out scientists from overseas drop in for a visit and to inspect the facilities. Members of the staff are always glad to show people who are interested, the laboratory layout, its equipment, and some of the projects under way.

IFT REGIONAL SECTIONS . . .

SPEECHES, SPECIAL EVENTS, NEWS NOTES

Finding the Facts Before Setting the Specifications. III. Avoiding the Wrong Approaches[a]

Julian H. Toulouse
Owens-Illinois Glass Co., Toledo, Ohio

LET US ESTABLISH at the outset of these comments on specifications one or two fundamental premises—first, that almost every business organization is at the same time both a buyer and a seller of some form of product or raw material. My company, for example, has thousands of customers, but we ourselves are the customers of thousands of other suppliers. The same is probably true of every organization here represented.

We follow specifications for the things we buy as well as the things we sell. Because of the manufacturing information required, the blueprint details of a bottle for the most meticulous customer differ little from those of a bottle for a customer who may not know that blueprints are needed. And the same is probably true in any field of manufacture, from mouse traps to diesel locomotives, from lipstick to the mechanisms for nuclear fission.

A second premise is that each of us sits on both sides of the bartering table. We must heed the same kind of details regarding quality standards in the things we sell that we do in the things we buy. We desire high performance in the things we buy; we must agree to give high performance in the things we sell. The interrelation of the buying and selling functions of a company is like the interrelation of pieces from a jig saw puzzle, or like the Yang and Yin of Chinese philosophy, each part finding its harmonious counterpart.

But, let us not think of specifications as being pertinent to only a producer-consumer relationship. Many specifications exist entirely within an organization and are of concern only between departments within the company. Take an automobile, for example. Hundreds upon hundreds of specifications are necessary for the component parts of their assembly; such specifications (except to the suppliers of materials) rarely get outside the place of automobile manufacture. What passes for "specifications" in the sales literature are merely recitations of a few standard dimensions, with only a hint as to performance.

Performance as the ultimate criterion. Whether hinted or spelled out in detail, *performance* is what is exchanged over the trading table. It is fundamental that the only excuse for a specification in any regard is to outline some necessary stipulation as to performance. Herein lies the reason, the basis, and the whole excuse for any expressions of specification, of tolerance, or of descriptive intent. All too many specifications go beyond this point into the field of conjecture, coercion, or fantasy to the end that difficulty is made certain, costs pyramid, waste is inevitable, and the specification itself becomes an anathema.

To correct this fault, I once made the plea, "find the facts before setting the specification" *(1)*. This plea is now renewed, and my part of tonight's program is to present some of the methods by which facts can be found. Since I believe so completely in the statistics of probability as a tool for study, the methods I will mention will all derive from statistical techniques. In a sense I shall be stressing the need for facts in order to emphasize statistical approaches.

I want to make clear at the outset that I believe too few specifications arise out of the facts of performance, which, I emphasize again, should be the only reason for a specification. Too many specifications are based on consensus or on compromise of opinion, or on mutual distrust, or on the game of claim and counterclaim. I believe that specifications should be arrived at by free

(Continued on page 8)

[a] Presented before the Chicago Section of the Institute of Food Technologists, November 12, 1956.

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(Continued from page 6)

discussion of the needs, and when so established, should be met and enforced.

How not to write specifications. It is not easy to detail, without exception, just what the right way to set up specifications should be. For that reason I shall approach the task in the opposite direction—by pointing out several wrong ways.

1. The Fine Print Method

Too many specifications include many details not necessary in the actual use of the article being specified. Blueprints for manufacture may have many dimensions necessary to develop the article but too often a specification for compliance includes every dimension on the blueprint. Do not confuse a specification detail with a working drawing.

2. The Umbrella Method

When specifications are the result of a group discussion of standards, they are often drawn so inclusively that "nobody is left out." When concerned with a group of producers, the specification is often set so as to include the weakest number of the group. When concerned with a group of consumers, it is often set to include the tightest specification desired by any one member.

3. The Shotgun Wedding Method

Dominance of one side results in a forced union. Compare the terms "buyer's market" and "seller's market." Each of these concepts produces a different idea as to specifications.

4. Keeping Up With the Joneses Method

Sometimes specifications are copied from another source without regard to their suitability to the product or purposes of the Company.

5. Go-You-One-Better Method

This method is based on number four — keeping up with the Joneses Method—but with additions, in an attempt to be more detailed or tighter than the "Joneses."

6. The Fiction Writer Method

This type of specification is so far removed from the actual needs as to bear no resemblance to "places, persons or events." In other words, this method overlooks the realistic and practical factors.

7. The Ostrich Method

This method results in completely ignoring the subject—burying one's head in the sand.

8. Peas in a Pod Method

Here is the method desired by the perfectionist. He does not believe in variation; all articles must be exactly alike. But did you ever look at a pod of peas?

9. You Go Your Way Method

Here we have a complete disregard of the value of specifications. Often set tight by engineering, the hope is that production will come close, or that production will set its own standards.

10. Hairline Method

No deviation whatever from tolerance, even by the most minute amount, is permitted. No concept of "average out-going quality" and statistics is shown. The services of a "material review committee" to decide on borderline quality are not considered.

11. Accent the Positive Method

Only that part of the production which is favorable to the side concerned is emphasized. This is what Irving Bross in *Design for Decision* calls "selective amnesia."

12. Damm the Torpedoes Method

Here we have no regard for the dangerous areas of cost—neither procurement cost for too tight a specification nor line loss because of an inadequate inspection.

Costs

If accurate costs are obtained, we can make a mathematical comparison to find the "best cost" specification. The accompanying chart (Figure 1) offers some of the factors involved.

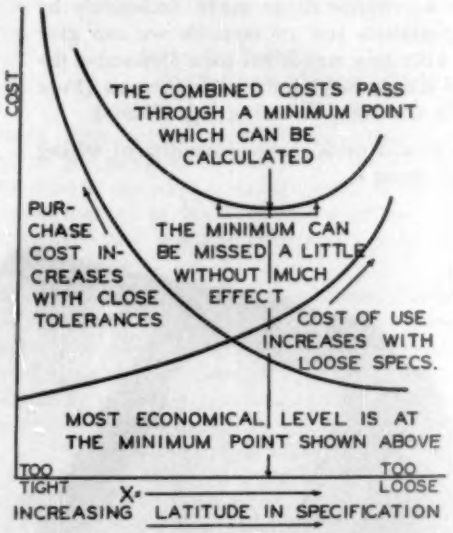
COST
THE COMBINED COSTS PASS THROUGH A MINIMUM POINT WHICH CAN BE CALCULATED
PUR-CHASE COST IN-CREASES WITH CLOSE TOLERANCES
THE MINIMUM CAN BE MISSED A LITTLE WITHOUT MUCH EFFECT
COST OF USE INCREASES WITH LOOSE SPECS.
MOST ECONOMICAL LEVEL IS AT THE MINIMUM POINT SHOWN ABOVE
TOO TIGHT
TOO LOOSE
INCREASING LATITUDE IN SPECIFICATION

Figure 1. A cost relationship due to change in specification.

Line costs decrease, for example, with less variable material; they increase as the variability increases. This is shown by the curve labeled *"cost of use increases with loose specifications."* Procurement costs go up with tighter specifications, simply because it can cost more to make such material. The curve marked, *"purchase cost increases with close tolerances,"* depicts this principle. The real cost is their *sum*. In the chart this is shown graphically to give the curve labeled, "the combined costs pass through a minimum point which can be calculated." This minimum is the best specification for the user. It is evident that it can be missed slightly without serious difficulty.

If each curve could be set up mathematically with "X" as the variation in tolerance the minimum point can often be calculated by the Calculus. The graphic method differs only in its ability to make determinations

(Continued on page 10)

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(Continued from page 8)

at enough points to describe a smooth curve, whereas the Calculus smoothes out irregularities.

Summary

Summing up this paper, the correctness of a specification is determined by the mathematical relationships between use and production, together with cost. Specifications fundamentally should be based on facts. The facts must be known first. They must come from a study of the product, its use, and its production. One of these three considerations alone, or any pair, is not enough. Therefore, correct specifications mean an open, cooperative effort by maker and consumer. Each party must be conversant with the problems of the other and both must be willing to study the overall problem.

Finally: Specifications are not rubber bands—to be stretched when necessary, then a little wider, and a little wider, until the whole structure fails.

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1. Toulouse, J. H. Finding the facts before setting the specification. Fifth Annual Convention, A. S. Q. C., 1951.
2. Toulouse, J. H. Finding the facts before setting specifications. II. The statistical approach. American Management Association, *Special Report No. 8*, 1956.

DIXIE . . . .

Dr. John Sharf, Glass and Closure Division, Armstrong Cork Company Research and Development Center spoke before the Dixie Section on February 8 on the effects of a nuclear explosion on foods. Dr. Sharf is a specialist in the processing and packaging of beverages, foods, drugs and related products. He was one of the scientists who observed the various violent effects of nuclear explosions on commercially packaged foods and beverages during the 1955 Continental A-Bomb tests. Dr. Sharf described the results of extensive laboratory examination of the exposed products and presented on-the-scene color photographs of the various details.

NORTHERN CALIFORNIA . . . .

At the annual meeting of the Section in December, held at the Western Utilization Research Branch, U. S. D. A., at Albany, Dr. Karl Friedrich Meyer, Hooper Foundation Director, gave an extremely thought-provoking talk on postwar Russia with a series of related statements that (1) We (the U. S. A.) are tightening our defenses against a possible war with Russia over middle eastern problems, (2) Russia is the largest industrial country in the world and (3) Russia and China have a combined population of over 950,000,000 people. Dr. Meyer recently spent over a month in Russia as a member of a team of four U. S. scientists sent on exchange basis for four Russian scientists who came here to study our polio work.

The U. S. group proceeded by DC3 from Helsinki, Finland to Moscow via Leningrad. On the ground it was travel by Zim car (Russian for Buick). Dr. Meyer's reactions to his visit were obviously those of admiration for the quality and quantity of the Russian scientific output, wonder at a people who could convert a subway station into a miniature museum of fine arts—and keep it as clean as one, disgust with the internal political immaturity and orthodoxy of its people and fear for the consequences of what he saw.

The best things in life are sold in Russia, but only to those with money. Money is distributed very freely to the fortunate few who are scientists, politicians or administrators. Others are obliged to forego such delicacies as caviar at $43.00 per can and oranges at $6.00 each. A scientist may consider the purchase of a home refrigerator at $2000.00, since this represents only one to two months salary, but the pick and shovel artist must take his food poisoning as it comes.

Dr. Meyer made his points and proved them with a series of beautiful color slides which lead one to suspect that his talents in the field of medical science have not been a hindrance in the field of photography.

—*From the* Hornblower *for January-February*

The Section met on February 7th at New Milani's Restaurant in Oakland. Following cocktails and dinner, Mr. William H. Smith, Director, Department of Research and Analysis, Federated Employers of San Francisco, addressed the group on "Human relations as a factor in job satisfaction." He discussed how selection of personnel for particular and general work presents problems of personnel management and labor-management relations that are important in all industries and particularly so in the food industries with heavy seasonal peak-load demands on both skilled and unskilled labor. To improve employer-employee relationships, increase efficiency, prevent costly lay-offs and disruptions of work, it is necessary to carefully select and plan for labor management. Mr. Smith has made many notable contributions to planning and analysis in this field.

PHILADELPHIA . . . .

Mr. Graham, Division Manager of Research of the Crown Cork and Seal Company, spoke at the February meeting on the history, growth, formulation, and packing procedures on whipped cream and toppings. Characteristics of new potential food aerosols were discussed. Problems of biological stability, public health regulations, formulation, and economics were outlined. Many food products would be at a disadvantage if dispensed aerated and the aerosol industry has been at work to overcome this difficulty. Relative merits of compressed gases compared with liquefied propellants were also discussed.

Successful commercial production of new food aerosols requires a combination of new food processing techniques with existing packing procedures. Considerable reformulation of existing food products and

(Continued on page 12)

Make Quality Your

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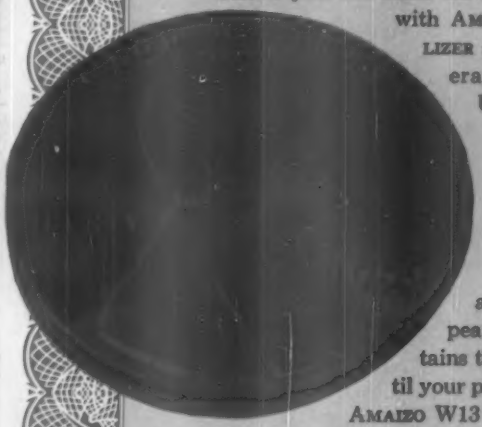

AMAIZO W13 STABILIZER withstands the extreme punishment of temperature differentials without breaking down. Your pies with AMAIZO W13 STABILIZER will maintain consistency without lumping or curdling, or becoming stringy.

AMAIZO W13 STABILIZER is specially prepared from amioca which is free-flowing, odorless and tasteless. Because of these outstanding characteristics of blandness of AMAIZO W13 STABILIZER, the full true flavor of the whole meat pie is considerably enhanced.

Leading food processors throughout the country have turned to AMAIZO W13 STABILIZER for their thickeners—you can save time and money by following their lead.

From your oven to the housewife's table—AMAIZO W13 STABILIZER, used in small amounts—can help amazingly to give your product the appetizing honest-to-goodness good eating quality that Mrs. Housewife is looking for.

Our Technical Service Department will be glad to assist you in any formulation or production problem you may have—call upon it without obligation. And ask your American Maize representative for samples and complete information on AMAIZO STABILIZERS for meat, poultry and fish pies.

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Myverol® Distilled Monoglycerides is our name for our food emulsifiers that consist of practically all monoglyceride and practically no soaps, catalysts, or free fatty acids. "Myverol" is our trademark. "Distilled" means we produce them by molecular distillation, which is what achieves this exceptional purity. The "Monoglyceride" can come from any food fat, cottonseed oil to prime steam lard.

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IN CAKE MIXES—with *Myverol* you can add the emulsifier separately, use it to compensate for variations in ingredients.

IN PEANUT BUTTER—you can use *Myverol* as a stabilizer to protect against "oil-out," to give a smoother-spreading product with less stickiness to tongue and palate.

IN HOUSEHOLD SHORTENING—very low levels of *Myverol* do a real job. You can use them after deodorization, and they keep the product in good working condition long after it reaches the kitchen cupboard.

IN ICE CREAM—*Myverol Distilled Monoglycerides*, along with an appropriate stabilizer, can be used to control overrun, produce a product with excellent dryness and melt-down.

In other products, too, like baker's shortening, chocolate coatings, and margarine, *Myverol Distilled Monoglycerides* can make a real contribution to product quality. We'll be glad to work it out with you. To get started, write *Distillation Products Industries,* Rochester 3, N. Y. Sales offices: New York, Chicago, and Memphis • Gillies Inc., Los Angeles, Portland, and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

distillers of monoglycerides made from natural fats and oils

DPi

Also . . . vitamin A in bulk for foods and pharmaceuticals

Distillation Products Industries
is a division of **Eastman Kodak Company**

(Continued from page 10)

the development of new forms of food products is required if new food aerosols, acceptable to the American public, will be possible.

"Bright Steel" a 30 minute color film provided by Bethlehem Steel Co. was shown at this meeting. This is an outstanding and fascinating story of tin plate, the versatile tin-coated steel product that made possible the modern canning industry—and revolutionized civilization.

SOUTHERN CALIFORNIA . . . .

The Southern California Section opened its packet of programs for the year 1957 on January 16th with a portent of things to come both as to future SCIFTS programs and also as to food studies. This was capably accomplished by the speaker, John H. Kilbuck who is Technical Director for Wm. J. Stange Company in Oakland. His topic was, *Foods for Special Environmental Situations* in which he included space travel, infantry combat, and cold weather conditions. He stressed the problems of weight and palatability of foods for space travel emphasizing the need for reduction of weight to the extent that recycling of metabolized water would no doubt be necessary inasmuch as man normally utilizes two and one-half liters per day and that the equipment necessary for carrying weighs ten times that of materials to be carried.

Mr. Kilbuck's presentation further maintained keen interest of the 60 members present by his recount of personal experiences in observing acceptability of foodstuffs by military personnel during combat duty. Of particular interest was the influence of some fresh food on the acceptability of other ration items in dried or canned forms and especially portions of fresh meats. He also pointed out that the satiety value was influenced by the type of foodstuff, fresh potatoes, for example, being superior to dehydrated potatoes in this respect.

His examples of food acceptability during cold weather training briefly encompassed the physiological advantage of warm food over cold rations. This was indicated by the response of marine troops carrying Sterno for the purpose of warming rations.

—*Submitted by* CORA MILLER, *UCLA*

NEW YORK . . . .

The New York Section held its first meeting of 1957 at the Brass Rail Restaurant on Wednesday evening, January 17. The third program in the 1956-57 series on the theme of product development included a talk and demonstration of "brainstorming" by Miss Jean Cordiner, copy supervisor of Batten, Barton, Durstine & Osborne and a pioneer of this technique of group thinking or "ideating."

Miss Cordiner described how brainstorming can be applied wherever new ideas are needed. Among the areas where the technique has been successfully used are new product development, new uses for old

(Continued on page 14)

Vitamin salesman without portfolio

This is Frank Dowe. He handles our sales of vitamin A in the New York area. He's shopping for a brief case because his wife says that anybody who is anybody ought to carry one. So the salesman shows Frank one with a big pocket for samples. No samples in this business, says Frank. So the salesman shows him one with a big pocket for catalogs. No catalogs in this business, says Frank. So the salesman shows him one that looks dressy but doesn't hold anything. But Frank thinks he looks ok as he is and buys a handbag for his wife instead.

Frank doesn't need a brief case because he's selling a service as much as a product. Back of him are a group of men who have devoted a large part of their working lives doing basic research on vitamin A. Also a production capacity capable of meeting your day-to-day requirements for Myvax® Vitamin A Acetate or Palmitate put up as Myvapack® Vitamin A to your individual requirements in batch-sized cans. If you happen to have any vitamin A questions, give us a call. Frank's office is on the 16th floor of the International Building of Rockefeller Center, and, although he's almost never there, his girl will give him the message. ***Distillation Products Industries,*** Rochester 3, N. Y.

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Also . . . vitamin E . . . distilled monoglycerides . . . some 3500 Eastman Organic Chemicals for science and industry

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(Continued from page 12)

products, new and improved production methods, and new sales and promotion ideas.

Miss Cordiner pointed out that brainstorming is best achieved through an informal group exchange of ideas by people who are not too closely connected with the problem to be discussed, nor bound by traditional thinking, knowledge of technical limitations or policy considerations. She emphasized that brainstormers must not be able to say "it won't work," "we tried it before and it didn't work," or "the company doesn't do it that way." A free flow of fresh ideas in rapid sequence will almost always produce ideas which are valuable and which would not have been obtained by conventional approaches to problem solving.

Following Miss Cordiner's address, an impromptu brainstorming session was held illustrating the techniques which had been discussed and the wealth of ideas which can come from such a session. Panel members included Dr. Fred Baselt, Miss Eleanor Crozier, Professor Roy Morse, Dr. A. Haldane Gee, Mr. George Parnam, Miss Barbara Balcom, Mr. Clair Kennedy, Miss Mona Oser, Mr. Jack Crattan, and Mr. Isadore Lewis.

Thirty-seven ideas emerged from a fourteen-minute discussion on the subject "What new food products would you like to have available by 1975?" The panelists' chief interest centered around more convenience in preparation for serving, improved nutritional value, improved flavors, and more versatility of basic foodstuffs.

The "Brainstormers" next attacked the problem of how to attract more and better young people into the food industry. Miss Cordiner's own suggestion—to give better publicity to the professional aspects of food technology, thus making it better known to the general public—illustrates her point that the solution to a problem might best come from someone not directly connected with the subject under discussion.

MARYLAND . . . .

The Section held its annual Christmas meeting on December 14th at the Stafford Hotel, Baltimore, with eighty-nine members and guests attending. As in the past, this was Ladies' Night and door prizes and liquid cheer replaced the usual more serious and technical portions of the program. Mr. William J. Hart, retiring Section Chairman, gave a talk on "New Product Development Procedures at the John H. Dulany & Sons Company." His talk was a blend of useful information and entertaining digressions.

The following officers were elected by the Maryland Section at the December meeting, to serve for the calendar year 1957.

Chairman: William A. Feild, 120 Melvin Avenue, Baltimore 28, Md.

Vice-Chairman: Dr. Richard L. Hall, McCormick & Co. Inc., Baltimore 2, Md.

Secretary: Irving I. Cohen, Strasburger & Siegel, Inc., 1403 Eutaw Place, Baltimore 17, Md.

Treasurer: Glenn Henderson, 726 Milford Mill Road, Pikesville 8, Md.

Councillor: William J. Hart, Jr., John H. Dulany & Son, Inc., Fruitland, Md.

The January meeting was also held at the Stafford Hotel. January 11, 1957 was the date and thirty-four members and guests attended. Mr. William Prouty, Director of Quality Control of the American Stores, Bakery Division, Philadelphia, Pa., was the speaker for the evening. His subject was "Product Evaluation, Scoring, and Quality Control in Production." His talk stressed the importance of integrated quality control based on these five factors: raw material quality control; process quality control; product quality control; quality control and production supervisor training; and finally, quality control and public relations.

A lively question period followed his presentation.

MOHAWK VALLEY . . . .

The annual meeting of the Mohawk Valley Section was held at the offices of Beech-Nut Foods, Canajoharie, New York on December 13, 1956. During the business meeting the following persons were elected to office for 1957:

Chairman: M. L. Kuboviak.
Vice Chairman: Dan Theokas.
Secretary: David DuBois.
Treasurer: C. E. Alford.
Counselor: T. F. Irmiter.

Following the business meeting "The Three Squares," a new and very excellent color film produced by the USDA in cooperation with the National Canners Association was shown. After the film members and their wives joined in singing Christmas carols accompanied on the piano by Dave Luscombe. Adding to the holiday spirit were appropriate decorations and Viennese coffee and home made Christmas cookies served as refreshments.

WESTERN NEW YORK . . . .

The Buffalo Subsection held its third meeting of the year on February 4 at the Park Lane Restaurant, Gates Circle, Buffalo. Guest speaker was Mr. Gerald B. Henry, President, Henry & Henry Inc. who spoke on "The present and future role of the Food Technologist in industry through the eyes of top management."

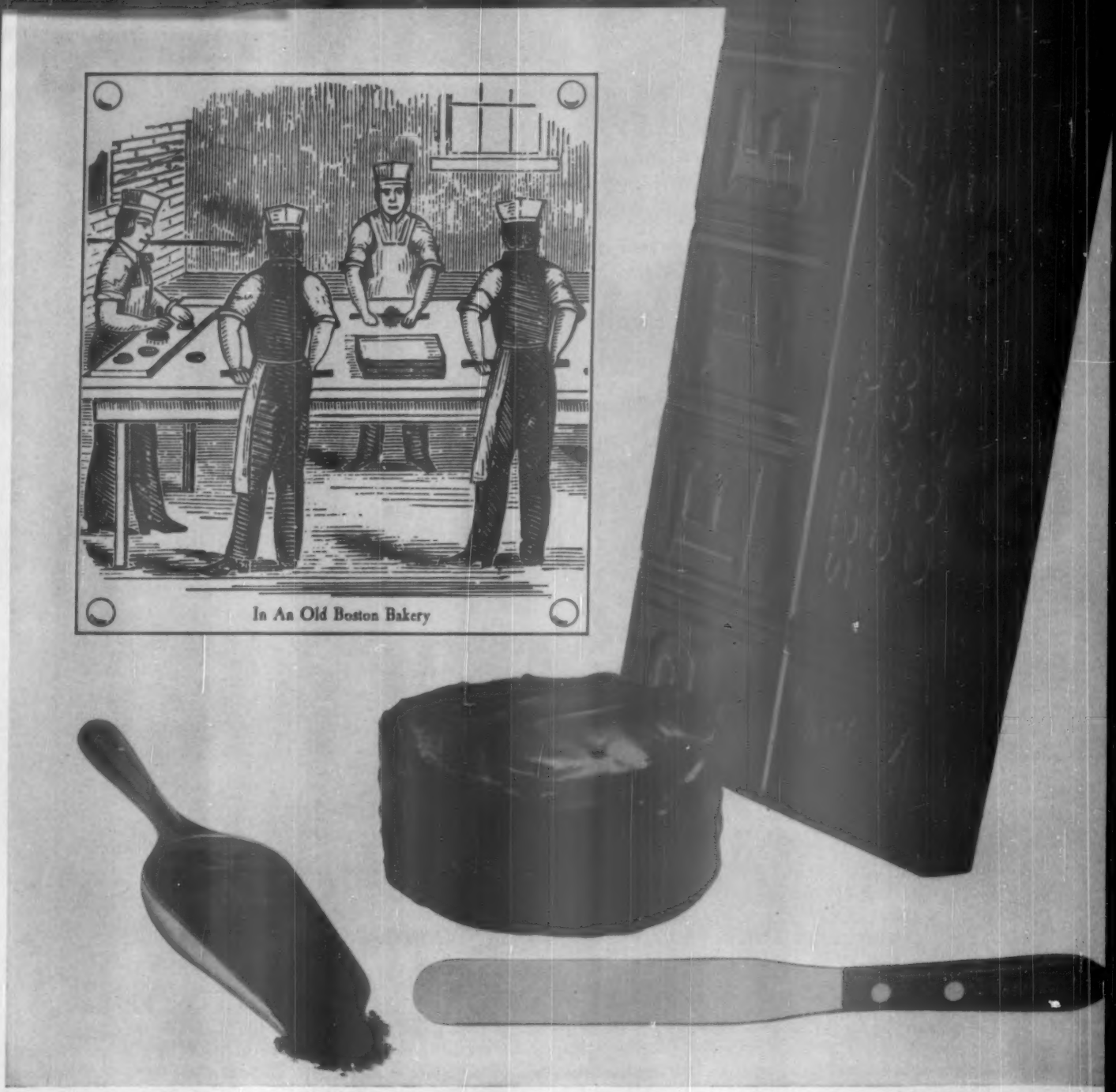
PERSONNEL

Eugene H. Allen, Jr., has completed his assignment as food technology consultant for the American and Italian Governments. Formerly stationed in Rome, Italy, he is now plant manager of the Dinner Ready of Virginia Corporation, Inc. at Timberville, Virginia.

Hugh L. Templeton, Fairmont Foods Company, Omaha, Nebraska, has been appointed a dairy technology adviser under the International Cooperative

(Continued on page 16)

In An Old Boston Bakery



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(Continued from page 14)

Administration and will participate in the development of the dairy industry in India. His headquarters will be the American Embassy, New Delhi.

DR. HARRY E. GORESLINE HONORED WITH PENB RESEARCH ACHIEVEMENT AWARD FOR 1956

"For outstanding scientific effort contributing to greater use of poultry and eggs" is the criterion for the selection of the winning nominee for the Poultry and Egg National Board's Research Achievement Award.

Dr. Goresline, 1956 winner, has fulfilled this stipulation in many ways—as a leader in the wartime sanitation program to control spoilage in egg dehydration and egg freezing plants, as a practicing bacteriologist, with more than twenty publications contributing to the solution of egg and poultry problems to his credit, and as an influential member of the leading technical and scientific societies in his field. He is a founding member of the Institute of Food Technologists and has held important posts in the Society of American Biologists, the American Public Health Association, as well as other professional groups. He has long been active in the Poultry Science Association, the professional society serving research and technology in this huge segment of the food industry. The Award was presented to Dr. Goresline at the annual banquet of the Poultry and Egg National Board, January 31, at the La Salle Hotel, Chicago.

During World War II, Dr. Goresline and his colleagues conducted an effective campaign to improve processing and storage procedures in poultry plants, particularly those producing dried egg. In-plant chlorination was one of Dr. Goresline's pet projects, and where it was introduced it proved to be a highly effective method for controlling the spoilage organisms and pathogens that attack poultry products. Perhaps Dr. Goresline is most familiar to the personnel of the poultry industry of the war years as the man who appeared on the scene periodically with his "laboratory on wheels"—to check up on operations and suggest improvements.

Dr. Goresline, who holds his B.S. and M.S. from Oregon State College, his Ph.D. from Iowa State College, began his Government career in 1930 as a bacteriologist with the USDA Bureau of Agricultural and Industrial Chemistry, and transferred to the Department of Defense in 1950, specifically to the Quartermaster Food and Container Institute for the Armed Forces, Chicago, where he is now Associate Scientific Director.

Dr. Goresline's predecessor Award Winners include Belle Lowe, George F. Stewart, Gladys Ellen Vail, Ernest Marvin Funk, Carl Henry Koonz, Helen L. Hanson, Alden R. Winter, William J. Stadelman (who made the presentation of the 1956 award) and Alvin A. Klose.

ANNUAL MEETING ANNOUNCEMENTS . . .

PREREGISTER AND SAVE TIME

Preregistration service for the 1957 Annual IFT Meeting in Pittsburgh will be available from March 1st to May 1st. This service is offered to avoid a rush of registrants on May 12th, the opening day. Members are urged to avail themselves of the preregistration service to save time for themselves and expense to the national organization. Preregistration forms can be handled quickly and efficiently by a limited number of personnel prior to the Annual Meeting.

Prior to March 1st, preregistration forms along with other information about the 1957 Annual Meeting, will be mailed to each member. Additional preregistration forms are available on request from Pittsburgh Section, Institute of Food Technologists, P. O. Box 1137, Pittsburgh 30, Pennsylvania.

Avoid standing in long registration lines while you can be enjoying Pittsburgh's hospitality. Upon receiving your preregistration forms, fill them in promptly and forward them with your check payable to the Pittsburgh Section IFT, P. O. Box 1137, Pittsburgh 30, Pennsylvania.

Sidelights on the Annual Meeting Tours

V. W. Vaurio, Chairman of the IFT Annual Meeting tours committee, has guaranteed that members gathering in Pittsburgh in May will have a wide range of choices of places to go and things to do. The tours committee has completed arrangements for trips to the Aluminum Company of America, the Duquense Brewery, Jones and Laughlin Steel Company, H. J. Heinz Company, Mellon Institute, and the U. S. Steel Research Center.

Where container metals are formulated. During their visit to the steel center of the world, IFT members and friends will be given the opportunity to witness a giant plant in operation as well as to learn of the relentless research behind such an operation. Activities of the U. S. Steel Research Center cover practically every problem area from winning the metal iron from its ores to manufacturing steel products. Of special interest to food technologists is the research work on container-metal quality, with special emphasis on tin plate and black plate. Members will learn of the re-

(Continued on page 18)

FLAVOR PLAYS A LARGE PART in the full enjoyment of a picnic luncheon. That's because typical picnic fare consists largely of food and beverage products which derive much of their appetizing appeal from the skillful use of selected flavors. In fact, the *superiority* of any of these products – *cold cuts, sandwich spreads, frankfurters, pickles, relishes, jams, flavored drinks, cakes and cookies – usually lies in the use of special flavoring blends carefully chosen or custom-made for a desired effect in a particular product. If you have flavoring problems and need the seasoned assistance of specialists remember FRITZSCHE . . . a first name in flavors since 1871. Remember also: *Your product is* ONLY *as good as its* FLAVOR!

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(Continued from page 16)

search on sheet steel with their attention focussed on enameled, galvanized and stainless steel products; and they will see for themselves the most advanced facilities for the development of steel materials for shipping and storing food products.

At the Aliquippa works of Jones and Laughlin the visitors can see an integrated steel plant where raw materials are processed into steel and a wide variety

United States Steel Applied Research Laboratory

of steel products. The "works" extends for about 4 miles along the Ohio River and is the center of one of Jones and Laughlin's large current expansion programs. Since a complete walk-through tour of this plant would take days, buses will transport the visitors to the 3 main points of interest within the "Works"—the open hearth furnace, the blooming mill and the tin mill.

Aluminum. While in Pittsburgh, IFT members will be privileged to tour the parent plant of the Aluminum Company of America. The New Kensington headquarters is located 18 miles north of Pittsburgh. The history of "Alcoa" is a story of farsighted individuals with an idea; they believed that aluminum was the "metal of tomorrow," and they had the courage and determination necessary to make this dream come true.

Molten steel, tapped from an open hearth furnace into this giant ladle, is teemed into ingot molds.

The world's leading scientists had worked for more than 80 years to discover a commercially feasible process to produce aluminum. Charles Martin Hall, who picked up the challenge of this dream while still studying at Oberlin College, succeeded in reducing aluminum oxide to metallic aluminum by the electrolytic process. The tour to Alcoa will include the Fabricating Division, Remelt, Extrusion Tube Foil, Jobbing, Cooking Utensil Manufacturing and Central Machine of the Machinery Division.

A brew house with a "brain." Perhaps one of the most popular tours will be that to the Duquense Brewery—a towering 11-story brew house which dominates the skyline of Pittsburgh's industrial South Side. This new brewery is among the most modern, both architecturally and functionally, of the brewing industry of the world. An inspection tour of the new structure gives the visitor an impression of a superbly planned and constructed enterprise highlighted by gleaming tile, stainless steel and bright copper vessels. One of the marvels of the brew house is an electrically regulated panel which controls the complete management of the grains throughout the brew house—from the railroad cars through all the various weighing and sorting operations in and out of the storage bins. The panel affords a precise inventory of raw materials on hand. It also controls the flow of materials into the brewing process and the handling of the wort. Popularly called "the electric brain" of the brew house, the panel with its series of lights, buttons and switches occupies an entire room.

On the IFT tours the visitor will note that each of the host companies, like so many other industries in Pittsburgh, is expressing its faith in its future by the expenditure of vast sums for improvement and expansion.

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1957

March 15-16	Annual Food Technology Short Course, University of Missouri, Columbia
April 23-25	Annual Meeting of the Research and Development Associates, Food and Container Institute, Inc., Jefferson Hotel, Richmond, Virginia
April 30	Forty-eighth Annual Meeting of the American Oil Chemists' Society, New Orleans, Roosevelt Hotel
April 30-May 2	A. O. C. S. Spring Meeting, Roosevelt Hotel, New Orleans
May 11-14	National Independent Meat Packers Association, Palmer House, Chicago
May 12-16	**Seventeenth Annual Meeting of the Institute of Food Technologists, William Penn Hotel, Pittsburgh, Pennsylvania**
May 14-16	Second Annual Industrial Nuclear Technology Conference, Museum of Science and Industry, Chicago
June 9-13	Seventy-fifth Annual Convention of the National Confectioners Association, Conrad Hilton Hotel, Chicago
November 18-December 9	Ninth Pacific Science Congress of the Pacific Science Association, Chulalongkorn University, Bangkok, Thailand

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, 11606 South Bell Avenue, Chicago 43, Illinois notices of annual or national meetings of interest to food technologists.

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IFT ACTIONS AND REACTIONS...

FISH PRODUCTS TECHNOLOGY INCREASING PROTEIN RESOURCES IN ASIA AND AFRICA —BUT NEEDS STILL GREAT

Opportunities for the vast development of trade in fish and fish products in Africa and Asia, and of the need for the mass of the people in these areas of the world to eat more fish, were commented on by Dr. William Hampton,* Chief, Fish Processing Section of the Technology Branch, Fisheries Division, Food and Agriculture Organization, when he returned to FAO's headquarters in Rome after a 15,000 mile tour of investigation.

"There is no doubt that the mass of people, who do not get enough protein in their diet, need the fish and that an immense opportunity exists in Africa and Asia to develop the fish trade," stated Dr. Hampton, "but wherever I went I found there were too few trained people to meet the needs and speed the development and too few facilities available."

In the course of his tour Dr. Hampton visited the Sudan, Uganda, India, Celon, Thailand and Pakistan.

"In Khartoum I found a typical example of the possibilities for development," said Dr. Hampton. "At the present time it is estimated that fishermen are taking about 30,000 tons of fish a year from the Nile and its tributaries and in the opinion of the local authorities this might be increased to 50,000 tons. They mostly dry-salt the fish but the process should be improved, and they should extend the curing and drying into the wet season—but that, again, is mostly a question of providing the necessary facilities such as a modern curing and drying plant.

"When I visited Entebbe, Uganda, I found they had a very promising enterprise, the Uganda Fish Marketing Corporation, but they are faced with problems of handling and processing techniques."

While in Bombay, India, Dr. Hampton studied the local fish markets and discussed with the authorities possibilities for improvement and expansion. FAO experts now working in India are interested in the problems of these markets and they also participated in the discussions. Plans, based on recommendations made by FAO exports, are in hand for building new markets.

Developments under the "Colombo Plan." "I was interested to meet a 'Colombo Plan' expert on cooperatives when I was in Mangalore," said Dr. Hampton. "He joined with our FAO Fish Marketing Expert and myself in discussions with the local authorities on marketing problems and on possibilities for marketing fresh fish and even canned and frozen fish in inland markets. Our discussions led to the idea of setting up a number of retail outlets in inland cities and towns and supplying them regularly with fresh fish by means of refrigerated trucks and also with canned and frozen fish. A pilot scheme would be attempted before making a decision to put the plant into full-scale operation. There was general agreement in the discussions as to the opportunities which exist for development of the fish trade.

"Another interesting development in fish processing is taking place in Colombo, Ceylon," continued Dr. Hampton. "The Canadian Government, under the Colombo Plan, have built a $3,000,000 plant for handling and freezing fish and are operating two trawlers to explore fishing grounds. This is a well-planned, modern enterprise which will be of great benefit to the fishing industry and people in Ceylon. The Canadians hope to enlarge the scope of the plant to produce fish oil and meal and also dried fish."

While in Ceylon, Dr. Hampton discussed research and development plans and research administration with the Government fishery officers.

"In Bangkok, Thailand, I saw the best fish market of any I visited on my tour," said Dr. Hampton. "It is new, well planned, with plenty of space and facilities for freezing and cold storage. It is an example of what can be done."

After studying the plants for producing fish sauces, fish paste and other fish products, Dr. Hampton reviewed experimental work being conducted in Bangkok by the Technology Section of the Department of Fisheries with the assistance of an FAO expert.

At Calcutta Dr. Hampton visited dry-salted fish establishments and at Karachi, Pakistan, he visited the site of the new fish harbour, designs for which were prepared by FAO experts.

"The filling-in is done and the site is now ready for the piles to be driven in and the new buildings to be constructed," reports Dr. Hampton. "While in Karachi I visited a frozen shrimp plant and discussed operating problems with the management. I was able to suggest answers to some of these. I also discussed with the authorities possibilities for the development of local markets for fish products, and particularly the idea of setting up retail outlets. Some outlets have already been established in Karachi. We also discussed technical research on fish products and processing. They have now reached the stage where more product development is needed, and the market opened up, and it was quite clear from my talks that they have the right ideas as to how to carry on this work.

"I also had the opportunity to meet some of the leading industrialists," added Dr. Hampton, "and I'm glad to say that they showed a lively interest in the fish business and this should lead, I believe, to some practical results in the near future."

SUPPLEMENTATION OF DIETARY PROTEINS WITH AMINO ACIDS

The possibility of correcting a dietary deficiency of an amino acid by supplementation with that acid is an attractive one. There are, however, several guiding principles which should be emphasized at this time.

(Continued on page 22)

* Dr. Hampton was formerly Director of Research and Development, General Foods Corporation (Seafoods Division), Boston, and later Manager of the Bird's Eye Fisheries Laboratories of the Corporation. He was the originator of the idea of pre-cooked fish sticks.

specialty flavors for candy and confections

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(Continued from page 20)

Attention is called to the Board's "Statement of General Policy in Regard to the Addition of Specific Nutrients to Foods," issued November 1953:

> "With carefully defined limitations, the principle of the addition of specific nutrients to certain staple foods is endorsed for the purpose of maintaining good nutrition as well as for correcting deficiencies in the diets of the general popoulation or of significant segments of the population. The requirements for endorsement of the addition of a particular nutrient to a particular food include (a) clear indications of probable advantage from increased intake of the nutrient, (b) assurance that the food item concerned would be an effective vehicle of distribution for the nutrient to be added, and (c) evidence that such addition would not be prejudicial to the achievement of a diet good in other respects."

Some twenty-five amino acids are needed for the formation of the various cellular proteins of the body and for other special metabolic functions. Most of these acids can be synthesized by the body, if dietary protein intake is adequate. There are, however, at least eight which must be supplied daily by the protein in the diet in proportions and amounts to meet the requirements of metabolism. Any dietary protein which is relatively deficient in one or more of these essential amino acids has a reduced nutritive efficiency. Emphasis is placed, therefore, upon the development of an adequate pattern of essential amino acids in the diet as well as upon the maintenance of an adequate protein intake. Although reasonable estimates can be made of the amino acid mixture which appears "ideal," the limits through which the pattern may vary and still be considered adequate are as yet unknown. Similarly, the definition of the amounts of protein of varying amino acid composition which are required for good nutrition under different physiological states requires further study.

There is reason for believing that nutritive requirements in disease may differ considerably from those in health. An amino acid pattern that is optimum for health and normal growth may require modification in pathological states in which the metabolism of one or another amino acid may be adversely affected. The study of amino acid metabolism in disease and the determination of desirable amino acid patterns in pathological states seem to be matters of great importance which may reveal particular needs for supplementation with specific amino acids or for the reduction of the intake of particular amino acids in the diet.

The imbalance of essential amino acids found in some dietary proteins cannot always be corrected by adding a single amino acid, the imbalance being the result of a deviation in several of the essential amino acids from an "ideal pattern" needed by the body. Multiple supplementation is generally required. This type of supplementation is at present best achieved by mixed diets where one food protein supplements another. The benefits to be derived from amino acid supplementation are uncertain until our knowledge of the consequences of amino acid imbalance is more complete. The Food and Nutrition Board recognizes the potential value of proper supplementation with amino acids and the desirability of intensive study of this problem.

FOOD AND NUTRITION BOARD
NATIONAL RESEARCH COUNCIL

REPORT OF THE MEETINGS OF THE COUNCIL, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, DECEMBER 27 AND 30, 1956, NEW YORK, N. Y.

Highlights of the Business Session. The Council elected Wallace R. Brode as President-elect for 1957, and Alan T. Waterman and Paul E. Klopsteg as members of the Board of Directors.

It has been proposed to merge the two Journals, *Science* and *Scientific Monthly*. This will increase the Association's publication costs. However, it is believed more advertising can be obtained because of the larger circulation.

The budget for the operation of the Association is set at $726,000.00. The income is about $686,000.00.

Upon recommendation of the Association's Committee on Affiliates and Associates and by endorsement of the Board of Directors, the Council voted to amend the Constitution to eliminate the category of Associates. All societies now listed as Associates of the Association are changed to the status of Affiliates.

Following the request of the Council, the Board reported that it had investigated the question of assessing all Affiliates $25.00 per Council member in order to raise a fund by which Council members attending a meeting could be partially reimbursed for their expenses. The proposal was not well received by the affiliated societies. Consequently, the Board recommended that no action be taken.

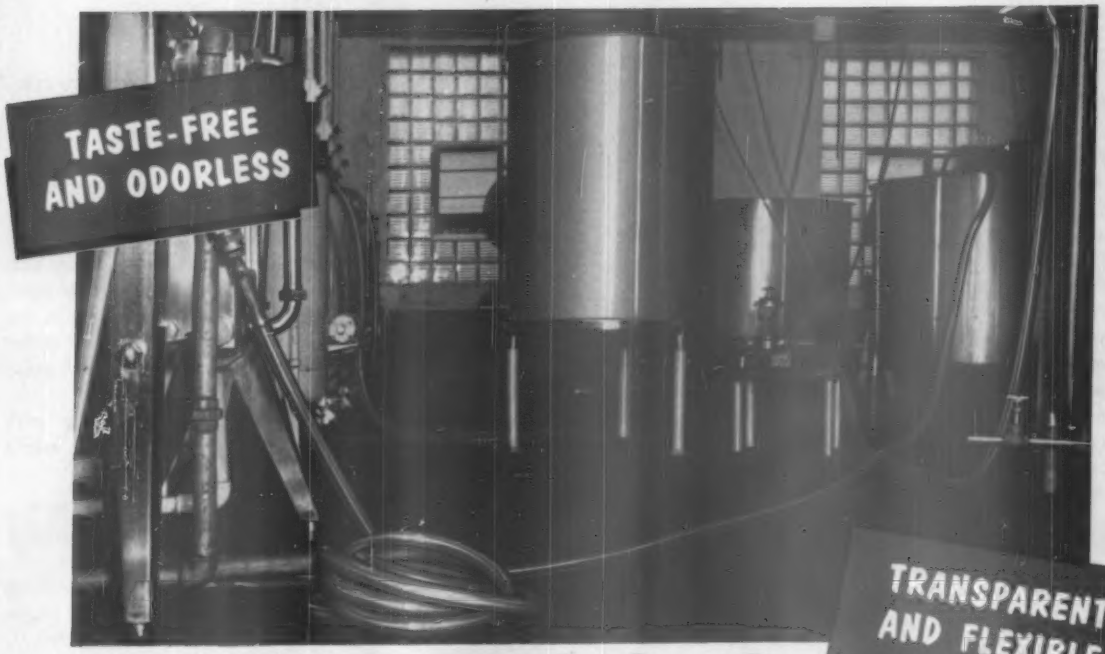
Social Aspects of Science. For a number of years the Council has felt that the organization was not fulfilling its function in improving the understanding of scientists in respect to the various categories of science and that it had not been able to increase public understanding of science and an appreciation of the methods of science as a means of progress.

Progress in science is creating social problems of unprecedented magnitude. This progress affects all people, and the backward countries are awakening to the needs for scientific progress in solving their problems.

It is clear that scientists themselves must understand the objectives of science and the implications which the newer discoveries of science have on our philosophy and modes of thought. Very few scientists have clearly conceived the results of scientific discoveries on the prevailing philosophy.

A number of interesting discussions were held under the title of "Moving Frontiers of Science." Two programs were held under the chairmanship of Howard Mumford Jones on December 27 and 28. The speakers discussed the physical, biological and social sciences, fundamental concepts and units of science. It was evident that the various philosophies presented could not

(Continued on page 24)



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(Continued from page 22)

be readily correlated, and various disciplines will have to await further discussion for clarification. However, these discussions were very helpful in presenting the views of representatives of the various sciences and will tend to stimulate more effective thinking on the part of those present as to the unity and aims of science.

On December 29 another symposium was held under the chairmanship of Dr. Yntema. Dr. Sinnott spoke on the common basis for development and behavior in organisms, and Dr. Niu spoke on chemical inducers in embryonic development. Dr. Prosser discussed functional and anatomic development of nervous systems in lower animals. The panel discussion covered single cell systems, aggregation of cells, colonies, and the effect of chemical and physical actions on nervous system development.

The address of the retiring president, Dr. Beadle, should be read carefully by every food technologist. He pointed out the importance of scientific men in effecting social change and progress, and the need for greater participation of scientific men in the affairs of the nation.

It is especially important that the younger generation, who are now in high school, be brought to realize the importance of science and the need of an adequate number of young people interested in science to enter college in order that our scientific progress can be maintained. In our struggle with the Communist world we shall need men and women thoroughly trained and in sufficient numbers to maintain leadership in creative and applied science.

The Association, I believe, is realizing its responsibilities in seeing that leaders of the various scientific categories are brought together and that the influences created by such meeting be widely disseminated and discussed not only for the benefit of scientists but for the education and welfare of the American people.

CHARLES N. FREY
Representative of IFT to the
American Association for the
Advancement of Science.

BOOKS . . .

ORGANIC CHEMISTRY, THIRD EDITION. By Louis F. Fieser and Mary Fieser. Reinhold Publishing Corp., New York, 1956.

The third edition of this book represents a thorough, up-to-date revision, not a 1956 model with a few changes in trimmings. It is the most readable and most comprehensive one volume textbook on organic chemistry available to the American chemist. It includes in addition to the classical organic chemistry, chapters on carbohydrate, fat and protein metabolism, steroids and vitamins which are usually covered in textbooks on biochemistry. Its readability stems from the ability of the authors to present facts in an orderly fashion. The inclusion of a new feature, the biographical sketches of 454 past and present chemists adds to the human interest phases of chemistry and must have taken considerable literature research.

In spite of the fact that this edition includes essential data gathered in the period between 1950-56 it contains 13 fewer pages than the second edition published in 1950. A regrouping of subject material under more inclusive headings contributed to a saving in space. For example, the chapters on microbiological processes and the role of carbohydrates and the chapters on rubber, synthetic fibers and synthetic plastics and resins in the second edition were combined in the third edition under the chapters headed carbohydrate metabolism and polymers respectively.

A food technologist interested in keeping up with the recent advances in organic and biochemistry would find this book a desirable addition to his library.

F. A. KUMMEROW
Urbana, Illinois

DOCUMENTATION IN ACTION. Edited by Jesse H. Shera, Allen Kent, and James W. Perry. 471 pages. Reinhold Publishing Corp., New York, N. Y. 1956.

DOCUMENTATION IN ACTION is a stimulating and highly important book. It concerns itself with two modern bibliographic needs—the organization of recorded knowledge for ready retrieval and for effective dissemination. With the broadening of scientific knowledge into new magnitudes and at the same time its deepening into esoteric specialisms, concern is being expressed in many quarters that this continuous accumulation of varied, abstruse, but nonetheless valuable knowledge is defeating its own purpose. In other words, knowledge is becoming less and less accessible. In this era of intense specialization it is no longer possible for one man or for one small group of men to command the sum of knowledge in a given field—neither in chemistry, or in engineering, or, to come down to cases, in food research and technology. DOCUMENTATION IN ACTION is a contribution to a new discipline, now emerging, whose responsibility will be to develop the art and science of systematizing and utilizing recorded knowledge for ready access and use. This discipline, as it evolves toward a perfection that it will probably never reach, will still be dependent on the human mind but it will be the "group mind" aided by information processing machines that will supplant or modify the traditional methods.

Traditionally, scientists and scholars have utilized such resources for searching the literature as encyclopedic compilations of the data in a field of inquiry (Beilstein), subject indexes (journals, books) or special bibliographies of individual or group authorship. Within recent times a phenomenal increase in abstract and review services has occurred. The trend toward evaluative documents, such as the ADVANCES type of survey, prepared annually or at least periodically, is yet another sign of the times. Add to these extensions of traditional methods of information retrieval, the invention and current, though still rather limited, use of automatic electronic equipment to ease the burden of locating information of interest in a given project or

(Continued on page 26)

One look at the huge, sprawling buildings at one of the Exchange Products plants and you know that big things are happening inside. For here *citrus* is king. Trucks pour in with fresh fruit from groves all over California and Arizona. Conveyer belts hum along in every direction. And Exchange products are shipped to nearly every part of the world.

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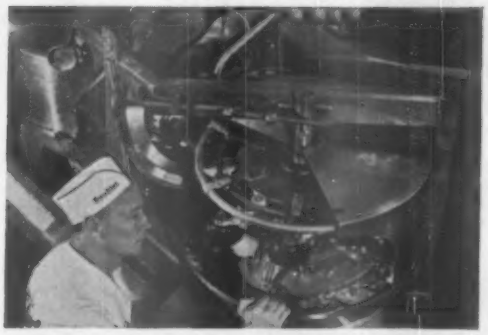

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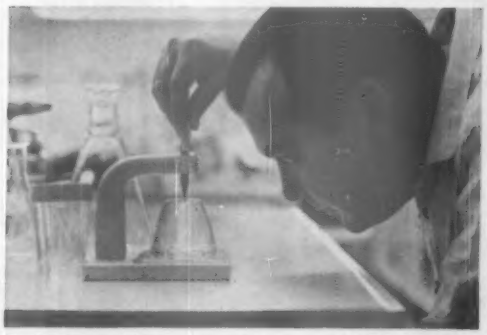

Exchange quality is assured by constant checking in extensive testing laboratories. In fact, rigid quality controls have been set up *throughout* the plant to make sure that every product measures up to Exchange quality. Sunkist produces more than 400 different citrus products.

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(Continued from page 24)

problem—and you can agree that a new discipline is indeed emerging.

DOCUMENTATION IN ACTION epitomizes and critically evaluates systems for organizing information and the equipment for fishing it up and making it available for use. Bringing recorded information to bear on research, or, for that matter, on management needs is discussed. The obligations of modern librarianship are also explored and enunciated.

The book is divided into four parts: I. Present Requirements, Methods and Problems—which includes expositions of the characteristics of recorded information, devices for analysis, storage and retrieval, and ways and means in which research, management, and other groups use information. II. Programs for the Future—which contains contributions on the international utilization of recorded knowledge, cooperative and centralized information processing, and the role of language in communicating recorded information. III. Discussion—which under this somewhat lazy title, presents some extremely interesting case studies of cooperative information processing in several fields—chemical research, metals, pharmaceuticals, petroleum, patents, medicine. In this section an essay entitled "Language Engineering" is well worth the attention of anyone interested in searching systems. IV. Cooperative Programs—which contains the essential questions asked in closed meetings and the answers that each group was able to formulate. V. Definition of Research Areas—which contains the areas of future emphasis, for one example, methods for analyzing the subject content of graphic records and for another, the design of scanning and identifying equipment.

DOCUMENTATION IN ACTION is not for the dilletante in the art of mastering a subject matter. Though far from exhaustive, it orientates the reader in the immensely important contemporary movement to get control of the literature of special fields, to correlate that literature with related fields, and to arrive, ultimately, at the goal of documentation—which is help the individual contributor to the stream of knowledge bring himself into conformity with the historical or objective facts in his field. "In the future," states J. H. Shera in the introductory essay of the book, "the major studies in man's understanding of the world about him will probably be derived through cooperative effort and will be developed by social, and perhaps even mechanical means."

MARTIN S. PETERSON
Chicago, Illinois

HIRSCHER, HERBERT. *Unterernährung und somatische Resistenz. Eine klinische Studie. (Undernourishment and Somatic Resistance. A Clinical Study.)* Akademische Verlagsgesellschaft Geest & Portig K.-G. Leipzig. 1953. 159 pages.

It is not necessary to dwell long on the many well-known observations that deficient nutrition in the vitamins and essential amino and fatty acids is associated with certain symptomatic disorders. This relationship, however, is not the main concern of the author of this study. His point of departure is to characterize the effect of deficient nutrition upon "somatic resistance." The concept of somatic resistance is taken to embrace "not only the processes and mechanisms . . . which protect the human body against living disease organisms (*i.e.*, natural infection resistance in the real sense of the term) but also those reactions which enable it either to make the animate and inanimate pathogens harmless or, at least, to overcome the illnesses caused by them."

The author's particular qualifications for this task reside both in his position as a head physician of the Medical Clinic of the University of Rostock (East Germany) and in his observations, and the studies of the clinic, on 320 dystrophy (malnutrition) patients. In addition, he has examined another 250 patients who were being treated for other diseases while suffering from deficiency illnesses. The observations were made during the first five years (1946-1950) which followed World War II.

Times of crisis and of war are generally associated with hunger and pestilence. Germany, which has richly experienced such periods during the last 40 years, is perhaps a logical environment in which a study such as this should be conducted. We recall the "Guns, not Butter" slogan of Hitler, which as early as 1935 started a period of deficient fat nutrition for the German people. As sharper crisis and then war followed, the deficiencies in nutrition became exacerbated. During the succeeding years of peace, not only the damages of hunger but also the increased susceptibility to various diseases have been noticeable.

Dr. Hirscher has initiated his observations with a background discussion of the modern literature of biochemistry, nutrition, and medicine which hinges about the effects of metabolic deficiencies. In the light of this literature he then reviews the pathological disturbances which may occur as a result of insufficiency of various proteins, of vitamins, of fats, etc. Unfortunately, he devotes only half a page to the very important consideration of the effects of a unilaterally massive carbohydrate diet. He also examines imbalances in mineral nutrition.

When he goes on to his particular clinical studies, Dr. Hirscher then considers the classical diseases of internal medicine from the standpoint of these modern ideas. He investigates his patients with the tools of the modern laboratory. First, he takes up altered resistance to infections of the skin and the mucous membrane, to tuberculosis, to *Endocarditis lenta (Streptococcus viridans* and other organisms causing infections in the blood stream), to virus hepatitis (yellow jaundice), and other diseases. For the most part, the lower resistance which occurs in all these cases is attributed to an insufficiency of protein. (The insufficiency is considered to be in the protein building blocks rather than in their caloric contribution or balancing effects in the diet.)

Next, alterations in organ resistance are studied: deficiency gastro-enteritis, "war" and "crisis" ulcers, deficiency osteopathology, and cancer. The above-named ulcers are clearly taken as extreme cases of deficient nutrition (particularly in proteins, though

(Continued on page 28)

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(Continued from page 26)

vitamins B_1 and C are used in the therapy), in which damage occurs to the stomach as a result of lowered somatic resistance, especially of the mucous lining. This section is accompanied by numerous graphic X-ray studies. In the case of the bones, the increase in tuberculosis of the bone and in spontaneous fractures is also believed traceable to protein deficiency.

Eleven cases of cancer were investigated in his patients. At the outset, Dr. Hirscher stresses that the evaluation of nutritional deficiency in cancer mortality must be based on thorough statistical studies, which are, of course, not yet available. (He is well aware of the environmental statistics regarding lung cancer and the relationships found with regard to "tobacco abuse.") However, there are studies which indicate the existence, in some cases, of a resistance to cancer development. Hence, the author is inclined to believe that the well-being of the reticulo-endothelial system may enter the cancer picture. This leads to the suggestion that nutritional deficiency may lower the body's resistance to cancer injury (*i.e.*, resistance not perhaps in the sense of hindering the onset of the disease but rather in slowing the rate of its development). Dr. Hirscher feels that the very rapid development of cancer which occurred in these patients, even the younger ones, indicates a much lower resistance to cancer injury, due—again—to protein deficiency damage to the reticulo-endothelial system.

The discussion on cancer has been summarized here not alone for its intrinsic interest but also to serve as a microcosm of the structure of the various studies which make up this clinical report. The discussions are always interesting and reveal a thorough grounding in modern biochemical and nutritional concepts. The author has ideas which have been fully bolstered with many references to other studies (over 600 citations are given in the bibliography.) However, as with some other writers, the range of the author's speculation often far exceeds the intrinsic reliability of the data at hand.

As a scientific study, Dr. Hirscher's work is disappointing. There is little substantiation in the clinical studies for the author's suggestions. Much is assumed, which should be more convincingly demonstrated. Often the validation sought here is simply not to be found. For example, in almost every case, a particular syndrome is ascribed to the deficiency in protein. Yet there is no experimental nor statistical proof of such a relationship in any part of the study. Apparently this finding has been based on a digestion of the relevant literature (in which the relationship has already been indicated) and on the assumption that most people in wartime Germany were obviously victims of protein—and other—insufficiencies in their diets. Although these facts are quite likely true, they can hardly be accepted as logically proving the author's contention on the basis of his own studies among his patients.

Another instance might be cited. The relationship between the incidence of tuberculosis and malnutrition is already quite well known. Yet, strikingly, the incidence of active tuberculosis and pleurisy among the 320 patients was only 7%, an extremely low figure (20-25% is more normal in such cases). The clinical findings for two patients are presented in the study, together with a detailed review of the literature on this question. No effort is made to indicate the relationship between the diets (or the cellular metabolism) of his patients and their tubercular state. Yet Dr. Hirscher's conclusion is that disturbances in the protein structure of the living cell are responsible for decreased resistance to tuberculosis and for the altered course of the disease in the patients whose nutrition has been deficient. This finding is not derivable from the observations here. It is not a valid relationship which may be drawn from the evidence presented.

A somewhat more subtle point deserves discussion. When clinical data are presented in the text, often the detailed diagnoses (plus *post mortem* findings, when available) are included. An inquiring reader begins to wonder, with such a wealth of pathological detail in some of the patients, whether any clear and simple relationship may be drawn between malnutrition and somatic resistance in these cases. Obviously, many variables are present in the medical history of these individuals, which have not been subjected to any sort of control. It becomes apparent that the total number of patients observed is dwarfed by the magnitude of the number of cases necessary to draw a statistical relationship of any degree of reliability.

The utility of this book lies in its assembling of the pertinent literature on deficiency nutrition and in its presentation of clinical examples of the course of various diseases which have been found in cases of malnutrition. Were its conclusions better founded, the book could be more readily accepted. Despite its interesting reviews and analyses of the literature, it cannot be recommended as demonstrating the author's findings.

CLARENCE STERLING
Department of Food Technology
University of California
Davis, California

RADIOISOTOPES IN BIOLOGY AND AGRICULTURE. Principles and Practice. By C. L. Comar. McGraw Book Co., Inc., New York, N. Y. 452 pages + indexes. 1955.

A principal purpose of this book as stated in the preface is to give the investigator an appreciation and understanding of how radioisotopes might be used in his research program and how research with radioisotopes might be conducted. Particular emphasis is placed on adaptation to the fields of physiology, nutrition, entomology, soils, and fertilizers. A bibliography of general and/or specific references is given at the end of each of the ten chapters, covering the literature through 1953 and part of 1954. Of particular interest to the investigator should be the very extensive glossary of terms used in modern nuclear science as well as the enumeration of available radioisotopes and their unofficial cost in 1955. The chapter on health physics and radiation protection is very instructive and should remove any apprehension which the investigator might have. Methods for radioassay and properties and pro-

(Continued on page 30)

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(Continued from page 28)

cedures for the individual radioisotopes are discussed in great detail, complete with a limited number of references after each, and detailed procedures for the determination of ionizing radiations by autoradiography, paper chromatography, and ion exchange follow in subsequent chapters. The printing of the book is excellent. Pertinent tables, figures, and photographs are interspersed throughout the text which is well organized and presented in a lucid style.

The book appears adequately to have met the stated principal purpose for the investigator at various levels and experience in educational institutions. It should also prove to be of interest and value to investigators in industrial laboratories even though possible applications of ionizing radiations to the food industry are not stressed.

SVEND PEDERSEN
University Park
Pennsylvania

FOOD INDUSTRY TOPICS . . .

. . . by Norb Leinen

The American people bought a record amount of food and grocery products in 1956, and continued gains are likely in 1957, according to Paul S. Willis, president of Grocery Manufacturers of America, Inc., 205 E. 42nd St., New York 17, N. Y. Total consumer food expenditures in 1956 topped $70 billion, compared with $67 billion in 1955 and $16 billion in 1939. With the industry's peak productivity, with a growing population, more families earning higher incomes, and more people wanting to live better, food spending may well reach $73 billion in 1957, he pointed out, adding that he expects the year to be one in which management will consolidate its gains, strengthen its financial position, and integrate its operations. This means, stated Mr. Willis, that while substantial sums will continue to be invested as management takes advantage of new developments in layout, electronic equipment, and automation, the hurry-up, catch-up pressure to add capacity is a thing of the past, and management will plan and select new capital outlays with great patience and study.

◆ ◆ ◆

According to Philip P. Gott, president of the National Confectioners' Assn., 221 N. LaSalle, Chicago, Ill., a number of elements appear to have entered into the increased production of candy in the year just completed. These include greater emphasis on higher quality of candy, greater recognition of merchandising with the goal of making available to the American public the best confections possible at the lowest price consistent with good management, at least a partial recognition by the public that candy eaten judiciously at the proper time and in the proper amount is a health benefit, and more aggressive merchandising by candy wholesalers and retailers with merchandising aids from the manufacturers.

◆ ◆ ◆

Industry production of metal cans in 1957 will approach 42 billion units, substantially topping the 1956 all-time record of some 40 billion containers, according to Wm. C. Stolk, president of American Can Company. Pointing to significant increases "almost across the board" in the production of cans during 1956, Mr. Stolk emphasized that the can industry has reached new production levels during each of the past 5 years, and said the upward trend will continue through 1957. He attributed the continuing production gains to the general high level of economic activity and to the fact that metal containers are being used in greater and greater volume to pack a constantly increasing number of products. He added that food cans constituted 62% of total 1956 metal container production.

◆ ◆ ◆

Cornell University's School of Nutrition, established in 1941, the first of its kind in the world, on October 26, 1956, became the Graduate School of Nutrition. Its program, a cooperative enterprise with various colleges of the University, includes course work and research in human and animal nutrition and in food technology, supply, distribution, and economics. Two professional degrees are granted—master of food science and master of nutritional science. Dean of the new Graduate School is Dr. R. H. Barnes, formerly director of the School of Nutrition.

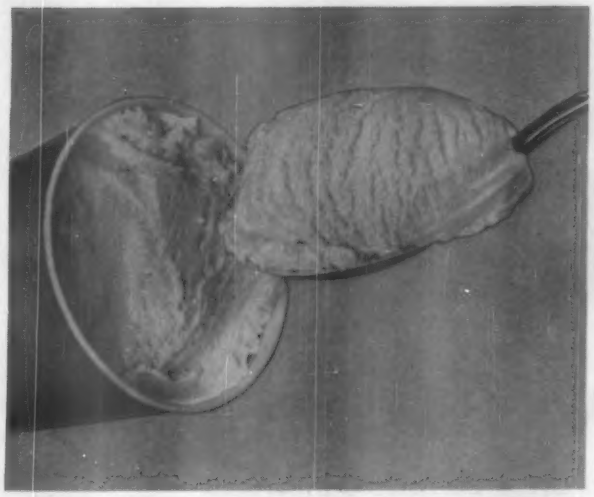
◆ ◆ ◆

Improved methods and apparatus for determining the volatile oil content of spices have been developed by the USDA's Eastern Utilization Research Branch, Philadelphia, in cooperation with the American Spice Trade Assn., 82 Wall St., New York 5, N. Y. The new procedures and equipment shorten analysis time, ease manipulation, and give greater accuracy compared to previous techniques. The improvements consist principally of modifications of the methods and equipment developed by J. F. Clevenger for the analyzing of essential oil content of plant products. The Clevenger system has been recognized as standard procedure for these tests.

◆ ◆ ◆

The "Brown Cows" worked overtime again in 1956. Production and sales of chocolate milk and chocolate dairy drink increased 5% during the past year, it was estimated by the Chocolate Milk Research Foundation. (Chocolate milk is made with whole

(Continued on page 37 following technical papers)



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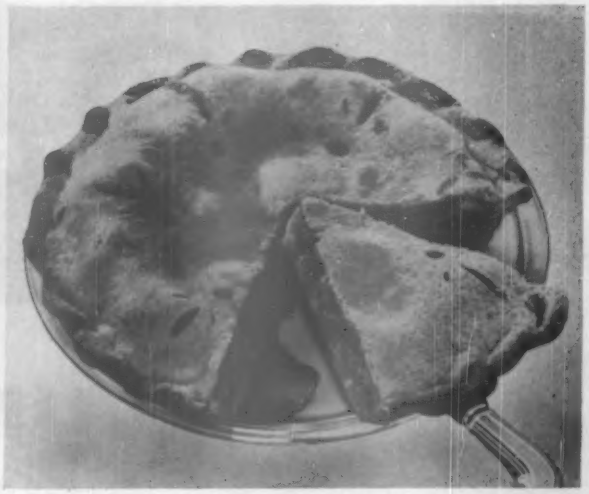

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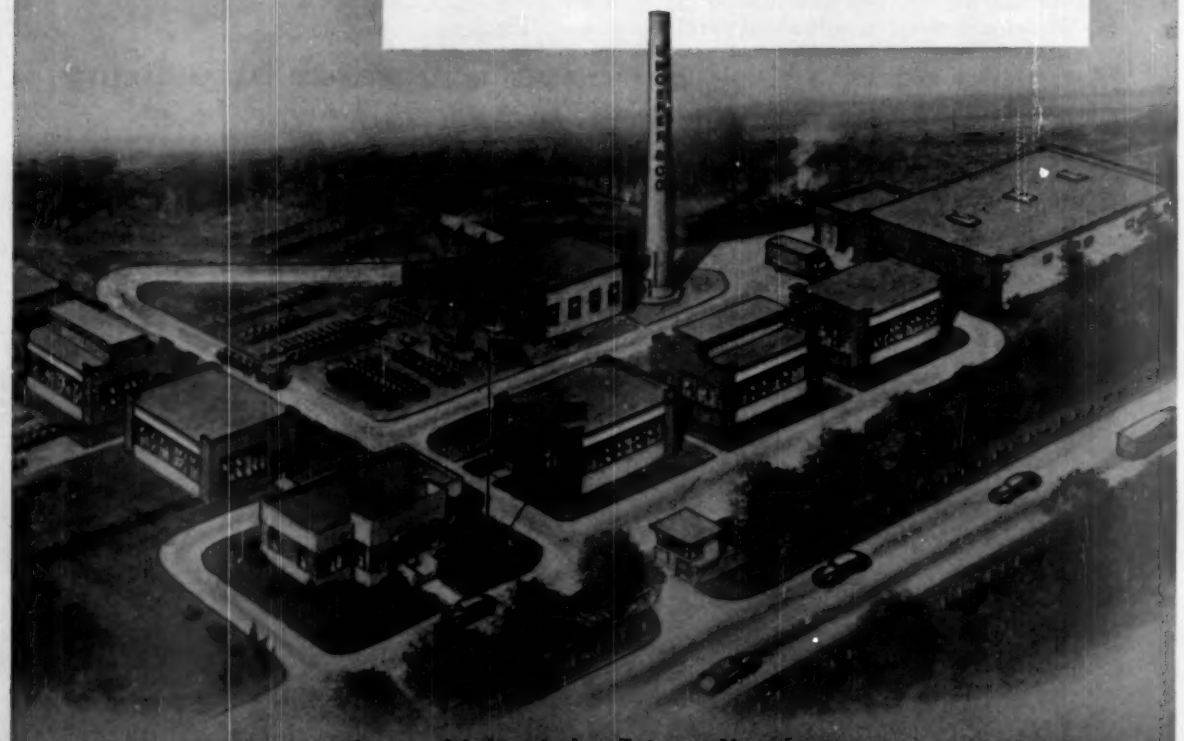

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The Recovery of Pectin from Orange Peel Extracts as Aluminum Pectinate[a, b]

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Department of Food Technology, University of California, Berkeley

(Manuscript received April 17, 1956)

SINCE THE INTRODUCTION in 1924 of the precipitation of pectins from citrus extracts by aluminum salts *(7)* only limited data have been published on the conditions affecting recovery of pectin by its use *(6, 9, 10, 12, 19)*. Originally, aluminum sulfate was preferred for precipitation *(7, 19)* but later aluminum chloride was proposed *(1)* and has now largely replaced the former in the industry *(6, 9)*. The aluminum salt solution was neutralized first with ammonia *(7)*; later sodium carbonate and calcium carbonate were suggested. The conditions of precipitation are only generally discussed in the literature and the actual pH range at which precipitation occurred has been specified only recently. This varied from 4.0-4.2, 4.0-4.5, 3.8-4.2 *(11)*. The precipitation originally was explained as mutual colloidal flocculation of the negatively charged pectin micelles by positively charged aluminum hydroxide sols *(7, 19)*, and this has been accepted generally in the literature except by Baker and Goodwin *(1)*, Deuel and Solms *(5)* who postulate cationic precipitation. Modern knowledge of the composition of the ionic species present in aqueous solutions of aluminum compounds *(3, 18)* has not been applied in investigations of the actual mechanism of the precipitation process and of the factors affecting it.

Quantitative data on the precipitation of pectins by "colloidal" aluminum hydroxide were not given by Jameson *et al. (7)* or Wilson *(19)*. In the more recently issued patent, Cole and Holton *(4)* point out the necessity of determining the precise quantity of aluminum chloride and of soda ash to be added to a particular pectin extract by experimental tests upon aliquots. For a pectin extract containing 0.5% pectin and having an acidity equivalent to 0.015 N they suggest addition of 12 ml. of an aluminum chloride solution (150 g. of aluminum salt per liter) and 7.2 ml. of 15% soda ash per liter but do not give any data on recovery or composition of aluminum pectinate obtained. They emphasize that the ratio of soda ash to aluminum chloride required for effective separation of pectin may vary with acidity of pectin extracts, concentration of pectin present, method of extraction and other factors.

The formation and properties of aluminum pectinates have been investigated recently *(10)* and in this paper data on the factors affecting recovery are presented. Although the data reported were obtained with pectin extracts obtained under one set of conditions, and represent pectinic acids of a particular degree of depolymerization and esterification, they illustrate the effect of precipitating conditions on pectin recovery. Data on commercial pectins and specially prepared pectinic acids differing in degree of esterification and molecular weight are presented elsewhere *(10)* and in general confirm the differences observed here.

[a] Taken in part from G. De Luca's Ph.D. Thesis, University of California, Berkeley, June 1954.

[b] Presented at the 14th Annual Meeting of the Institute of Food Technologists at Los Angeles, Calif., June 1954.

EXPERIMENTAL PROCEDURE

Preparation of the pectin extract. The orange peels, immediately after the extraction of the juice, were cut into thin slices. The slices were about 2-5 mm. thick to facilitate a rapid heat transfer in order to inactivate the enzymes and to allow a better extraction by the inorganic acids. The sliced material was heated in hot water to 80° C. for about 5 minutes to inactivate pectinesterase, and to remove sugars and other soluble constituents. The heat treated peels were washed and then pressed to further eliminate soluble solids. One kilo of peel, prepared in this manner, was added to two liters of water acidified with sulfuric acid to a pH of about 2.4-2.6. The mixture was heated for half an hour at 100° C., and then one more liter of water was added to decrease the viscosity of the liquid to facilitate the filtration. The mixture was filtered through cotton cloth. The pectin extract, still cloudy, was filtered again with diatomaceous filter aid. The clarified pectin extract was cooled and stored at 0° C. until used. It contained 0.36% of galacturonic acid and about 0.5% of alcohol precipitable material.

Analytical methods. The total pectin in the original extract was determined after precipitation with alcohol by the modified carbazole method *(11, 15)*. This was used also for the analysis of aluminum pectinate precipitates and solutions, usually after removal of aluminum by treatment with cation exchange resin *(10)*. The ash content was determined by ignition in muffle furnace.

RESULTS AND DISCUSSION

Effect of pH on the recovery of pectin. The first series of experiments was carried out by adding the aluminum salts adjusted to various pH values, to solutions of pectin at the same pH value as the salt added. Aluminum chloride, aluminum sulfate and potassium alum, the salts used, were adjusted with the alkalis, sodium carbonate and ammonia, since they are commonly employed in industrial precipitations. Previously reported data showed that the type of alkali does not have a great influence on the behavior of the aluminum salts, i.e., on the formation and solubility of the basic salts *(10)*.

Sodium or potassium hydroxides were not used with the pectin solution because of the danger, even in contact for a few seconds with the pectin solution, that they might cause local de-esterification of the pectin molecule.

In each precipitation, 30 ml. of aluminum salts, 1 M in Al^{+++}, were added per each liter of pectin extract. These are the proportions generally used in the pectin industry. Alum was used in the precipitation in the same manner as was the aluminum chloride and the aluminum sulfate, but no precipitation resulted. A precipitate with alum was obtained only on adding the salt first and then the alkali. The pectin losses, however, were very large (60-75% of the total pectin present in the original solution).

The relationship between the pectin lost (unrecovered) and the pH at which the precipitation was performed is shown in Figure 1. For aluminum chloride the graphs for the two alkalis used are similar and the

optimum yield was not affected by the alkali used; both showed the same optimum pH of precipitation (3.8). The optimum pH of precipitation with aluminum sulfate, however, differed with alkali used; with ammonia the pH optimum was 3.96 and with sodium carbonate it was 4.1. In both cases, the use of ammonia resulted in more complete precipitation. The data plotted in Figure 1 clearly show that the aluminum chloride is

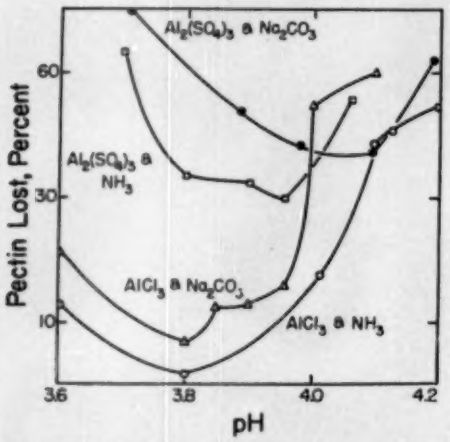

Figure 1. Effect of pH, alkali, and aluminum salt on the content of unprecipitable pectin.

more efficient than the aluminum sulfate as a precipitation agent.

Another difference between the aluminum chloride and the aluminum sulfate is that the latter can precipitate pectin only within a limited range of pH (3-7-4.2) whereas the aluminum chloride forms a precipitate over a somewhat wider range of pH, between 3.4 and 4.3.

The formation of a precipitate referred to actually is the "curd" formation *(6, 9)*, the aluminum pectinate curd which forms, rises to the top of the vessel and is easily separated and pressed. Other forms of precipitates can be obtained at higher pH values, but these differ in physical and chemical properties *(10)*.

In the pH range in which precipitation occurs, the aluminum species are present both as monovalent ions corresponding to the structure $Al(OH)_2^+$ or $Al_2(OH)_5^+$ and bivalent ions $Al(OH)^{++}$*(3)*. Actually these basic cations are highly solvated and polymerized in solution but stoichiometrically they are characterized by a determinable OH : Al ratio. We have found that in the curdy pectinate forms, both with aluminum sulfate and aluminum chloride, the ratio of OH : Al is about 1.25 and in the amorphous pectinates of higher ash content the ratio of OH : Al is about 2.25 *(10)*. The readily separable aluminum pectinate curd can not be considered to be formed by mutual colloidal precipitation and is not formed by a simple cationic flocculation.

The anions present in solution affect the properties of the basic salts by complexing and other reactions. In aluminum chloride solutions a higher concentration of basic cations is present than in aluminum sulfate and there is less of the more complex highly polymerized sol. Aluminum chloride in solution at pH 4.0 is clear and does not contain appreciable amounts of polymerized solvated hydroxide sol. The aluminum sulfate solutions at this pH range are less stable, become cloudy owing to aggregation and have a greater tendency to coprecipitate with pectin. The presence of anions which will exchange with hydroxyl groups or which form insoluble aluminum precipitates will also affect precipitation. Thus the results obtained by McCready *et al. (13)* that pectin extracts obtained with polyphosphates require twice as much aluminum chloride for precipitation as similar pectin extracts without phosphate can be explained on the basis that aluminum phosphate is completely precipitated at pH 3.0 *(8)*. It is only after phosphate ion concentration has been reduced that the aluminum hydroxy cation concentration will be sufficient to precipitate pectins.

Relation between the pH of precipitation and the ash content of the resulting pectinates. Figure 2 shows the increase in ash content of the aluminum pectinates with increase in the pH of precipitation. The ash content of the pectinates varies within a large range from about 8 to 25%.

Effect of the concentration of the aluminum salts on the recovery of pectin. The effect of varying the concentration of aluminum salts on the recovery of pectin is shown in Figure 3. Each precipitation was carried out with one liter of pectin extract with a galacturonic acid content of 0.36%. Precipitations were made by adding aluminum salt solution, 1 M in Al^{+++}, in three different aliquots, 15, 30, and 60 ml. In all precipitations ammonia was used as alkali. It was not possible to obtain a precipitation when 15 ml. of aluminum sulfate were added. Increasing progressively the volume of aluminum sulfate from 30 to 60 ml. did not result in any change in pectin recovery. The optimum pH of

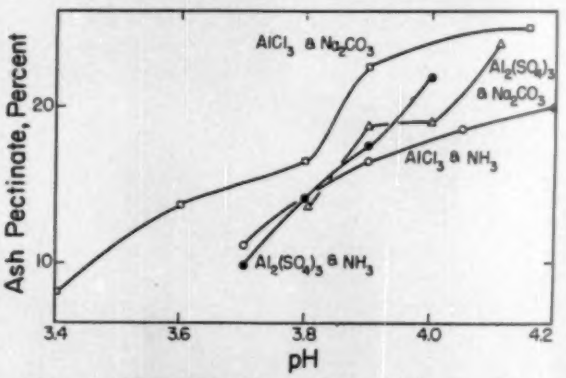

Figure 2. Effect of conditions of precipitation on ash content of aluminum pectinates.

precipitation for both volumes of aluminum sulfate was 4.0, as in the previous series of experiments. By increasing the amount of aluminum chloride, however, a remarkable increase in recovery of pectin is achieved. With 60 ml. of aluminum chloride at the optimum pH the recovery was almost quantitative. The concentration of aluminum chloride present also apparently influences the pH optimum of precipitation.

Effect of the concentration of the aluminum salts on the ash content of the resulting pectinates. The ash content of the various pectinates isolated at various aluminum concentrations are plotted against the pH

of precipitation in Figure 4. Increasing the volume of aluminum chloride added from 15 to 30 ml. resulted in a marked increase in the ash content of the pectinate obtained. When 60 ml. of aluminum chloride were added, the ash content in the pectinates increased only by a small amount.

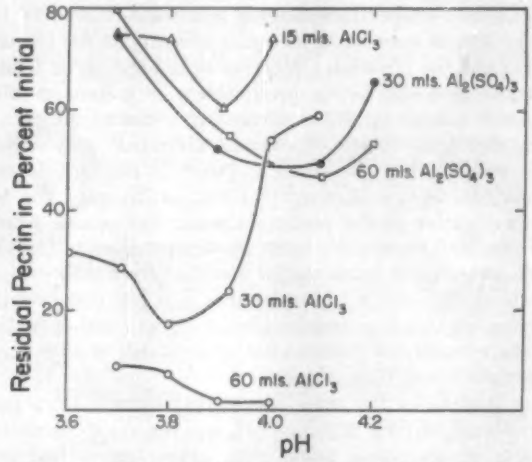

Figure 3. Effect of volume of aluminum chloride and aluminum sulfate solution added on recovery of pectin.

With aluminum sulfate, however, the ash content of the pectinate increased when the volume of the salt was doubled. This can be explained easily from the previous inventigation of the aluminum salts *(10)* which indicated that the aluminum sulfate exists in the colloid state at the pH at which pectin precipitation takes place. With increased amounts of basic aluminum sulfate, higher ash contents are obtained because of co-precipitation of basic aluminum sulfate. At a lower pH there was little difference in the ash content of the pectinates.

This difference increases at pH 4.0 where the basic aluminum sulfate starts to precipitate. The aluminum chloride, however, in this pH range is still in the soluble form and this explains why the amount of salt added does not have a significant influence on the ash content of the resulting pectinates.

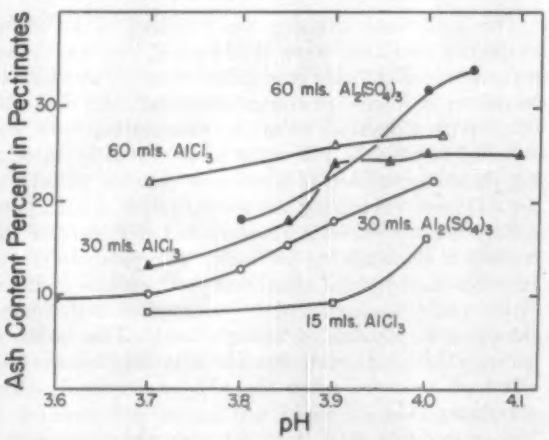

Figure 4. Effect of volume of aluminum chloride and aluminum sulfate added on ash content of aluminum pectinates obtained.

Effect of chloride and sulfate anions on the recovery of pectin. The complex basic aluminum sols usually contain less than one equivalent of anion, other than hydroxide or oxide, per equivalent of aluminum but can form complexes in which the coordinated hydroxide is displaced by sulfate, chloride or other anion *(18)*. The complex with chloride is more stable than with sulfate and the Cl-Al bond persists during aging and dehydration. It is known from the literature *(2, 16)* that the presence of sulfate anions influences floc formation from alum. It was shown elsewhere *(10)* that aluminum chloride solutions form a stable sol, while, under similar conditions, aluminum sulfate forms a flocculant precipitate. According to Miller *(14)* the absence of sulfate anions in the colloidal suspension of aluminum chloride

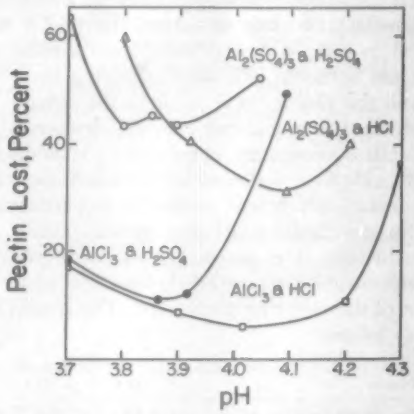

Figure 5. Effect of type of acid used in extraction of pectin and type of aluminum salt used in precipitation on recovery of pectin as aluminum pectinate.

is the reason for the narrow pH range within which aluminum chloride forms a floc in distilled water. He pointed out that aluminum chloride will give the same results as aluminum sulfate, providing an equivalent of sodium sulfate has been added. By adding a sufficient quantity of sodium sulfate, the sol will coagulate as a result of the decrease in zeta potential. In view of this effect of sulfate anions and particularly because it had been reported previously *(17)* that sulfate interfered with precipitation of pectin by aluminum, the influence of sulfate was investigated in some detail.

For this purpose the orange pectins were extracted with hydrochloric acid at the same pH, temperature and time used with sulfuric acid. The resulting pectin extract had a galacturonic acid content of 0.37%. Precipitations were made with this extract with aluminum chloride and aluminum sulfate at different pH values.

The results obtained are shown in Figure 5, which on comparison with those obtained from pectin extracted with sulfuric acid, Figure 1, indicate that the pectin extracted with hydrochloric acid is more easily recovered from its solutions.

With eitiher aluminum chloride or aluminum sulfate

as precipitating agents, the presence of sulfate anions results in a decrease in the amount of pectin recovered. The pH optimum of precipitation, in the case of the aluminum chloride in the absence of sulfate ions, is shifted to a slightly higher value. Without sulfate ions, also, the pH optimum of precipitation occurs over a wider range.

Effect of the method of precipitation. Often in industry, the precipitation is carried out by first adding the aluminum salt, followed by the alkali, either ammonia or sodium carbonate, until the curd formed rises to the top of the precipitation tank. In this method of precipitating pectin, however, it is difficult to add the alkali to the proper pH. As a consequence, it is difficult to obtain a good recovery of pectin. Instead, by the additions of the aluminum salt to the pectin solution brought to the same pH value as the salt, the pH optimum of precipitation can be easily maintained.

To compare methods of precipitation a new series of experiments was made in which the pectin was precipitated in three different ways from a same extract: (1) at the optimum pH, after adjusting the pectin extract and the aluminum chloride to the same pH value; (2) adding the aluminum chloride first and then the alkali until a precipitate is formed; (3) adding aluminum chloride first, followed by the alkali, exactly in the same amount which was needed in experiment (1) to bring to the desired pH the pectin extract and the aluminum salt. The percentage of pectin recovered in each operation was recorded together with the ash content of the resulting pectinates. The results obtained were as follows:

Sample	(1)	(2)	(3)
% pectin recovered	90.1	74.75	93.75
% ash in pectinate	15.7	12.95	17.90

These results show that to precipitate pectin by first adding the aluminum salt and then the alkali, the amount of alkali that should be added at the pH optimum must be known.

Effect of the rate of addition of aluminum salts. The effect of varying the rate at which the aluminum salts were added to the pectin solutions on the recovery of pectin was investigated. Two samples of 1000 ml. each of orange peel extract, containing 0.36% of galacturonic acid, were precipitated with 100 ml. of 0.35 N aluminum salts, after both the pectin solution and the aluminum salt were adjusted to the optimum pH. The total volume aluminum salt solution was added at once and in 1 ml. portions. In a third experiment, the alkali and the aluminum salt used, after adjustment to the same volume, were added alternately (1 ml. of each at a time) to the pectin extract. The results obtained were as follows:

	Pectin lost (%)		
	Suddenly	1 ml. at a time	Alternately
Aluminum sulfate precipitation	44.71	38.9	40.1
Aluminum chloride precipitation	10.65	28.3	19.4

The data shown above indicate that it is preferable to add the aluminum salt suddenly in the case of aluminum chloride, while, when the aluminum sulfate is employed, the addition of the salt 1 ml. at a time or alternately with the alkali results in higher recovery.

Effect of the temperature of precipitation. In industry the pectin is extracted from the raw materials generally at a temperature ranging between 70° and 100° C. The temperature has a favorable effect upon the extraction and the filtration. Whether or not the pectic liquid has to be cooled before precipitation by aluminum salts is still unknown. When alkalis are added to the pectin extract local zones of over-alkalinization may exist, especially when the stirring system in the tank is not efficient. It is well recognized that alkalis cause the de-esterification of the pectin molecule, the rate of which increases very rapidly with the temperature *(11)*. On the other hand, many pectin manufacturers still precipitate at high temperature, because it is felt that precipitation at high temperature gives a higher yield of pectin. The recovery of pectin when precipitated at high temperature was determined.

Aliquots of the same lemon peel extract were precipitated, at their optimum pH, and the same concentration of aluminum salts, with aluminum sulfate and chloride at room temperature and at 70° C. The pectin lost in each precipitation was determined with the following results:

	Pectin lost, %	
	30° C.	70° C.
Aluminum sulfate precipitation	44.85	21.50
Aluminum chloride precipitation	27.83	12.10

These results indicate that at high temperatures higher yields are obtained. The effect of the temperature during the precipitation, on the degree of esterification and polymerization of recovered pectin and the influence of temperature upon the pH optimum of precipitation was not determined.

SUMMARY AND CONCLUSIONS

The conditions affecting the recovery of pectin as aluminum pectinate were investigated. It was found that aluminum chloride gave better recovery and formed pectinates of lower ash content than did aluminum sulfate. With aluminum chloride optimum recovery was obtained at pH 3.8; this could be increased by increasing the concentration of aluminum chloride present in the mixture. Increasing the concentration of aluminum sulfate did not increase recovery but did increase ash content of the resulting pectinate. The presence of sulfate decreased yield of aluminum pectinate and optimum yields could be improved by extraction with hydrochloric acid instead of sulfuric acid. The order of addition of aluminum chloride and alkali had little effect on recovery when the pH was optimal. With aluminum chloride rapid addition of salt resulted in higher recovery than slow but with aluminum sulfate gradual addition of aluminum salt and alkali was necessary for best recovery. Precipitation at 70° C. resulted

in higher recovery with both aluminum salts than at 30° C.

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Flavor Permeability in Food Packaging And Its Evaluation[a, b]

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(Manuscript received June 13, 1956)

The quality of food products as they reach the consumer depends, to a large extent, on the protection afforded by the package. Protection is determined primarily by the functional properties of the packaging material. Of particular importance is the package permeability to liquids, gases, and vapors. Adequate methods for the determination of permeability are therefore needed as a guide and as a means of control for protective packaging.

As a result of considerable work by various groups, a number of methods for the determination of permeability to water vapor and to fixed gases have been developed and reported in the literature. Permeability to organic vapors, however, has so far received much less attention. The importance of this property in the packaging of food items is obvious since it is directly connected with the flavor loss and odor pickup by the product. The need for flavor permeability studies has been reviewed thoroughly by Elder *(2)* in 1947 and will not be discussed here.

Methods currently available have severe limitations. The most widely used consist of the packaging of a volatile material, storage for a long period, and the determination of volatiles lost by weight difference. The main difficulty in applying this method is the time required for the test.

The Cherepow method *(1)* is based on the determination of the time required for an odor or flavor to pass a packaging material in quantities sufficient to be detected organoleptically. The objections to this method are that it is subjective, and hence may contain errors due to differences in sensitivity to odors between different individuals, that it is influenced by the presence of odors in the test room, and therefore requires special facilities.

The organic vapor permeability method *(6)* utilizes the rate of transfer of methyl furoate as an index of permeability. The furoate that passes through the sample is absorbed in potassium hydroxide and the liberated furoic acid is determined spectrophotometrically. Although this method avoids the difficulties of the Cherepow method, it has other limitations, most important of which are:

1. Since the method measures the permeability of materials to only one volatile compound, a rating system for the relative efficiency of different packaging materials for the packaging of odor-sensitive foods could be based on it only if different materials had the same relative permeability to all organic volatiles. This

[a] Presented at the Meeting of the Institute of Food Technologists, St. Louis, June 1956.

[b] Contribution No. 304 from the Department of Food Technology, Massachusetts Institute of Technology.

is almost certainly not the case for plastics and plastic laminated materials.

2. Unpublished results of experiments carried out in the Food Technology Department, M. I. T., have indicated that the rate of absorption of methyl furoate in potassium hydroxide is dependent upon the concentration of furoic acid already absorbed. Thus, the partial pressure differential across the film changes throughout the test and the calculated permeability is subject to error.

In view of the considerations mentioned above, it was considered that a need still existed for the investigation of other methods for the measurement of permeability to organic volatiles. The permanganate method of Lang and Farber has been demonstrated to be an effective means of estimation of some food odors and flavors *(3, 5)* and an application of it to the problem seemed logical. Some preliminary experiments by Proctor and Landrock showed promising results. Oswin *(7)*, in a recent book, also mentions the possibility of using the method for the estimation of flavor transfer through packages.

The authors have undertaken, therefore, a study of the reaction of alkaline permanganate with organic volatiles, and the applicability of the method to quantitative measurement of permeability to such compounds. This paper presents the results obtained in this investigation.

BASIC CONSIDERATIONS IN THE PERMANGANATE METHOD

The method of Lang and Farber is based on the trapping and oxidation of organic volatiles in an alkaline solution of potassium permanganate. The permanganate solution is then acidified with sulfuric acid, potassium iodide is added, and the liberated iodine is titrated with sodium thiosulfate, with starch as an indicator. The amount of iodine liberated depends upon the amount of permanganate present. The difference between the titration results obtained with the blank and the results from the treated sample is taken as an index of the amount of organic volatiles trapped in the permanganate.

In order to apply this procedure to permeability measurements it was necessary to determine whether the reaction is quantitative under the conditions of the test.

In the course of this investigation it became apparent that such was not the case, and that several precautions had to be taken in order that the method should yield reliable results. The limitations are due to the peculiarities of the reaction with alkaline permanganate, and these are discussed below.

The reduction of permanganate in acid solution involves a gain of 5 electrons for each permanganate ion:

$$MnO_4^- + 5e^- + 8H \text{ - - - - } Mn^{++} + 4H_2O \ldots\ldots (1)$$

The change of valence is thus 5, from a manganese valence of +7 to +2. The gram-equivalent weight of permanganate for oxidation-reduction reactions in acid solutions is therefore one-fifth of the formula weight.

The reaction in alkaline solutions, however, proceeds according to the following scheme:

$$2KMnO_4 \text{ - - - - } 2MnO_2 + K_2O + 3O \ldots\ldots\ldots (2)$$

Only 3 equivalents of oxygen are therefore produced in an alkaline medium instead of five. The obvious implication of this fact for the Lang method—in which the volatiles are oxidized in alkaline solution but the final determination takes place in acid medium—is that no matter what the amount of volatile reducing substances the apparent reduction value will never exceed 60% of the amount of permanganate determined in the blank in acid solution.

Further complications arise from the fact that reaction (2) takes place in two sharply divided stages. The first stage, which is rapid at room temperature, proceeds as follows:

$$2MnO_4^- + 2\ OH \rightleftharpoons 2\ MnO_4^{--} + H_2O + O \quad (3)$$

This reaction, therefore, is characterized by the reduction of permanganate to manganate; one equivalent of oxygen is produced per manganate equivalent in this stage, and the gram equivalent weight is equal to the formula weight for this stage of reaction.

Second stage of reaction is characterized by the reduction of manganate (Mn^6) to Mn^4. The reaction can be schematized as follows:

$$MnO_4^{--} + 3H_2O \text{ - - - - } Mn(OH)_4 + 2\ OH^- + O \ldots\ldots (4)$$

In this stage, two equivalents of oxygen are produced for each manganate ion. This stage of reaction, however, is extremely slow, and complicated by concentration, pH, and other effects. Holluta *(4)* states that stage 2 (eq. 4) does not take place until stage 1 (eq. 3) is completed.

A series of experiments was conducted to study the rates of reactions in the different stages of the process. Aliquots of known concentrations of 3 organic vola-

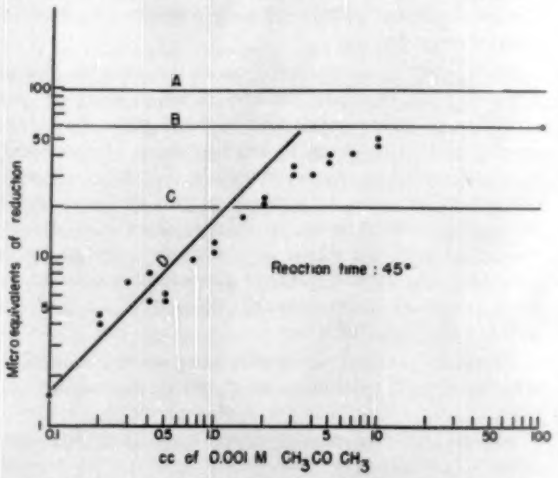

Figure 1. Reduction of 0.004 M alkaline permanganate by acetone.

tiles—acetone, ethyl alcohol, and trimethylamine—were added to known amounts of alkaline permanganate, and allowed to react for different periods of time at room temperature (25 to 30° C.).

Results of these experiments are shown in Figures 1 to 4. Line A represents the total number of permanganate equivalents available in acid medium, Line B 60% of A, and Line C 20% of A. Line D represents in each case the theoretically expected maximum reduction of permanganate assuming a complete oxidation of the organic compound. Figure 1 shows results obtained with acetone using 0.004 *M* permanganate. The reaction time was 45 minutes. It is evident that the reaction followed Line D until approximately 20% of the permanganate was reduced. Further addition of acetone resulted in a decrease of the slope of the curve and the experimental points tended to approach B as an asymptote.

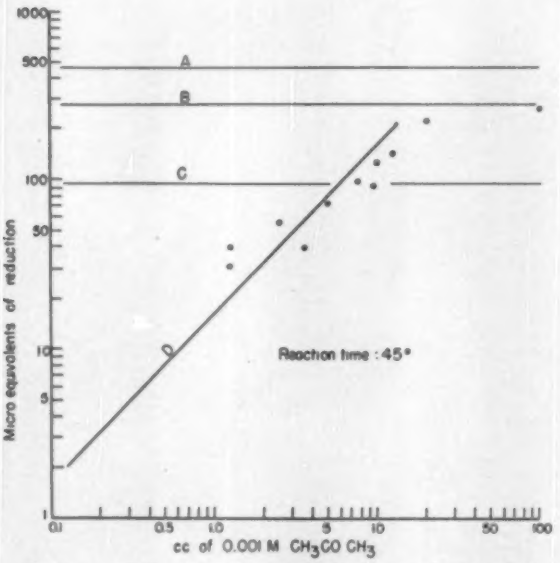

Figure 2. Reduction of 0.02 M alkaline permanganate by acetone.

Results using acetone and 0.02 *M* permanganate are shown in Figure 2. The same general pattern was followed. Further experiments using different reaction times showed that the first stage was completed within 15 minutes, but that above 20% the reaction did not become quantitative even after 24 hours at room temperature.

Figures 3 and 4 show the results obtained with ethyl alcohol, using 0.02 *M* and 0.004 *M* permanganate, respectively. Different reaction times were used to determine the rates of reaction at room temperature. The results followed the pattern apparent in studies with acetone, except that the first reaction stage was somewhat slower.

Further results were obtained using trimethylamine. As in the case of previous experiments, the theoretical expectations were confirmed. The reaction in the first stage was slower than for acetone and one hour was

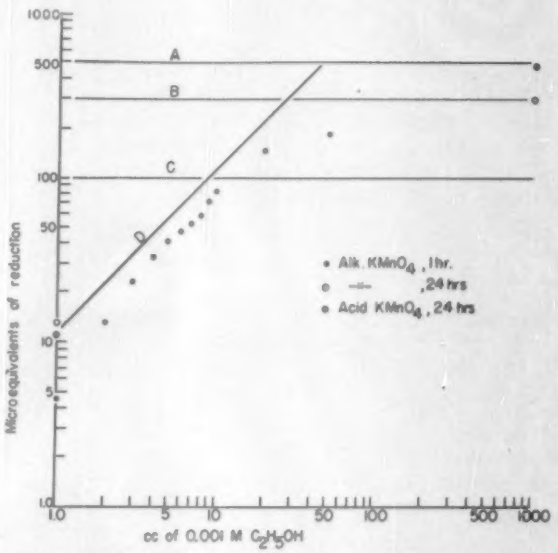

Figure 3. Reduction of 0.02 M alkaline and acid permanganate solutions by ethyl alcohol.

needed for the experimental points to reach the theoretical curve.

On the basis of these experiments it was concluded that only the first reaction stage can be used for a quantitative determination of organic volatiles and that the apparent reduction of the sample (compared with the blank) should be kept below 20%.

A convenient check on the progress of the reduction is the color of the solution. Permanganate in alkaline solution has a typical purple color. Manganate in alkaline solution has a bright green color. As long as there is excess of permanganate available, the reaction will be

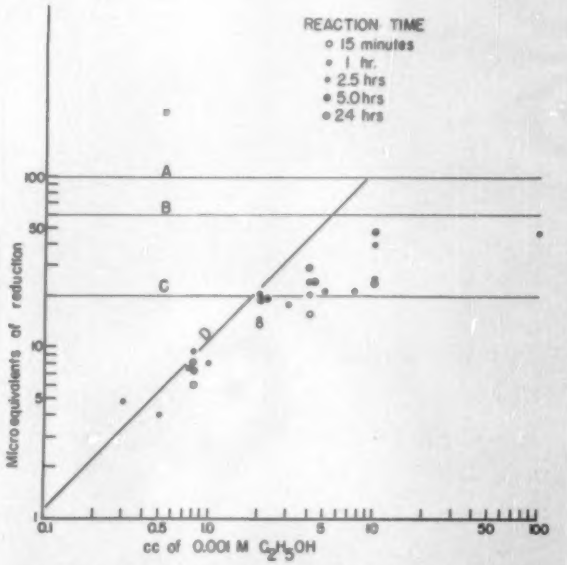

Figure 4. Reduction of 0.004 M alkaline permanganate solutions by ethyl alcohol.

limited to the first stage. Combination of the green manganate and the purple permanganate colors results in blue or dark purple solutions. The appearance of green color indicates that the first stage has been completed and that the reaction is no longer quantitative.

On further reduction, the color scheme is complicated by the appearance of brown manganous dioxide, the solubility of which is low, so that a precipitate is formed rapidly. This results in the development of an olive green solution, which changes to a brown turbid suspension.

ESTIMATION OF ORGANIC VAPOR PERMEABILITY OF PACKAGING MATERIALS METHOD

On the basis of the above considerations a procedure was developed for the testing of permeability to organic volatiles. The apparatus used is shown in Figure 5. It consists of a flowmeter, an air purification train, a humidity control flask, a gas permeability cell, two reaction flasks, a back pressure bottle and a vacuum pump.

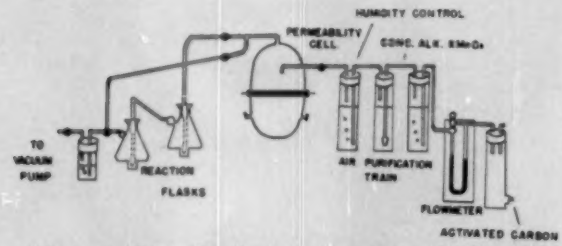

Figure 5. Schematic diagram of apparatus for determination of organic vapor permeability.

The all-glass permeability cell is identical to that used in the Linde permeability apparatus *(8)*.

The procedure used is as follows:

1. A sample of the film to be tested is placed between two parts of the permeability cell.

2. The system is swept with purified air to remove any volatiles trapped in the connections and to establish the desired humidity.

3. A small amount of the organic volatile is placed in the lower part of the permeability cell.

$$P = \frac{W_A}{(A)\,(t)\,(VP)}$$

$$PC = (P)\,(x)$$

WHERE :

P = PERMEANCE

W_A = WEIGHT OF THE VAPOR TRANSFERRED

A = AREA OF TEST FILM

VP = VAPOR PRESSURE

PC = PERMEABILITY

X = FILM THICKNESS

Figure 6. Equations used in calculating organic vapor permeability.

4. Alkaline permanganate is placed in the two reaction flasks.

5. The system is swept with purified air again, bypassing the two reaction flasks.

6. The time is noted and the air stream diverted through the reaction flasks. The test is continued for 30 minutes. By choosing an appropriate concentration of alkaline permanganate the reduction is kept between 10 and 20% for each test.

7. The exact amount of permanganate reduced is determined by titration.

8. The amount of permanganate reduced is corrected by subtracting the reduction due to the removal of volatile substances (plasticizers, etc.) from the sample itself, rather than that due to the permeation of the test volatile. The correction values are obtained by blank runs without the addition of any volatile substances to the lower part of the cell.

9. The amount of volatile organic substance transferred during the test is determined from the amount of permanganate reduced using the previously established calibration curve for the organic compound.

10. Permeance and permeability are calculated by the use of the equations shown in Figure 6.

RESULTS

Using the procedure outlined above, tests were conducted on the permeability of 7 different packaging materials to ethyl alcohol vapor. All tests were conducted at a room temperature of 25-28° C. and a relative humidity of approximately 85%. The results obtained are shown in Table 1. It is evident that aluminum foil, saran, and saran-coated cellophane had the lowest permeability; polyethylene and cellophane, the highest; and mylar, an intermediate permeability.

TABLE 1

Permeability of several materials to ethyl alcohol vapor

Material	Gage inches	P	P. C.
Aluminum foil	0.0007	0.034	0.024
Saran coated cellophane	0.0009	0.100	0.090
Polyethylene coated cellophane	0.0014	0.880	1.240
Nitrocellulose coated cellophane	0.0009	1.500	1.350
Polyethylene	0.0015	4.250	6.400
Mylar	0.0010	0.680	0.680
Mylar	0.0020	0.346	0.692
Saran	0.0020	0.163	0.326

P = Permeance, mgms/m² — hr.-mm.Hg. Partial pressure diff.
P.C. = Permeability, mgms-mils/m² — hr.-mm.Hg.

In other experiments the permeabilities to ethyl alcohol vapor of mylar films of different thicknesses were determined. Figure 7 shows the results obtained in this experiment. A straight line relationship was obtained when the reciprocal of permeance was plotted against film thickness.

Results obtained in experiments on the permeability of packaging films to acetone and trimethylamine vapors

TABLE 2

Permeability of some materials to acetone and trimethylamine vapors

Material tested	Gage inches	Vapor	P	P. C.
Aluminum foil	0.0007	Acetone	0.030	0.021
Saran	0.002	Acetone	0.049	0.098
Mylar	0.001	Acetone	1.750	1.750
Mylar	0.007	Acetone	0.197	1.380
Polyethylene	0.0015	Acetone	3.77	5.65
Aluminum foil	0.0007	TMA	0.001	
Saran	0.002	TMA	0.043	0.086
Mylar	0.001	TMA	0.085	0.085
Polyethylene	0.0015	TMA	0.095	0.140

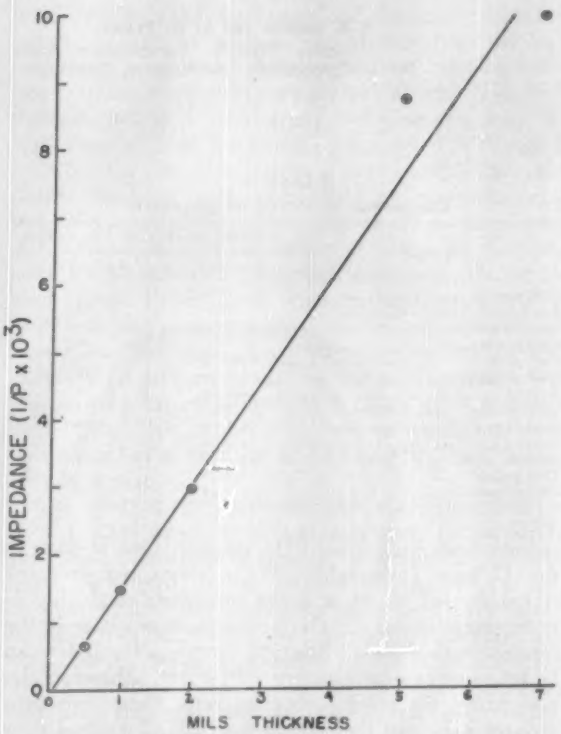

Figure 7. Impedance to ethyl alcohol vapor of mylar films as a function of film thickness.

are shown in Table 2. The results obtained with acetone were similar to those obtained using alcohol vapor—with the exception of mylar film, which showed a much higher relative permeability.

Permeabilities of the different films to trimethylamine vapor were of the same order of magnitude except for aluminum foil, which had a very low permeability.

Further experiments are in progress on the permeability of packaging materials at low humidities and on the effect of changing the partial pressure of the organic vapors by dilution with water and other solvents.

SUMMARY AND CONCLUSIONS

The experimental conditions under which the permanganate process of Lang and Farber allows the quantitative determination of organic reducing substances were determined. A procedure for the estimation of permeability of packaging materials to organic vapors was developed and tested. Results were obtained on the permeability of several packaging materials to the vapors of ethyl alcohol, acetone and trimethylamine.

On the basis of the results obtained, the following conclusions seem warranted:

1. The proposed procedure offers a rapid and accurate method for comparison of different materials from the point of view of their permeability to organic vapors.

2. Further studies are needed to determine the precision of the method.

3. Further studies are also required to determine the correlation between the results obtained by the permanganate method and the organoleptic evaluation of flavor and odor transfer.

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Color of Capsicum Spices. II. Extraction of Color

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(Manuscript received March 31, 1955)

IN THE FIRST ARTICLE of this series *(2)* a spectrophotometric method for measuring the color of extracts of capsicum spices was described. At that time no thoroughly tested procedure for preparing extracts was available and the one employed was selected because of its widespread acceptance in the industry. This method, which appears to have evolved from a procedure first proposed by Lowenstein and Dunne *(1)*, is lengthy, lacks precision, and requires a costly solvent, 95% ethanol. The present report describes the development of an improved procedure employing a 3-hour extraction with 99% isopropanol.

While this paper was being prepared Shuster and Lockhart *(4)* published the results of their investigations on the same subject. In their method, the color of capsicum spices is extracted by maceration with acetone for 24 hours.

METHODS AND MATERIALS

The samples examined were representative of the entire capsicum line. The Gentry method *(2)* was used for measuring the color of all extracts. This method determined color in Gentry units *(2)* which were then converted, through the use of tables or graphs, to either the Lovibond units *(2)* or the newly-developed linear color units *(3)*. As recommended in the third publication *(3)* of this series, in most instances, color values determined with 99% isopropanol are reported in linear color units, while Lovibond units have been reserved for results obtained with 95% ethanol. However, to facilitate comparison of results, linear color units have been used for both solvents in some cases. All color determinations were run in duplicate.

Unless otherwise specified, the extracts were prepared by placing 0.100 g. of sample in a 2-ounce bottle and adding 50.0 ml. of solvent. The bottle was stoppered tightly, shaken, and placed in a temperature-controlled water-bath, the height of the water being slightly above the height of the solvent in the bottle. The water-bath was fitted with a cover to prevent light from striking the samples. Following extraction the sample was shaken again and filtered. The filtrate was held in the dark while being cooled to room temperature.

Four solvents were used in this investigation—absolute ethanol (U.S.P.), 95% v. ethanol (U.S.P.), 99% isopropanol (% w., min., 99.0; sp. gr., 20/20° C., 0.785-0.787) and 95% isopropanol. The three former solvents were obtained from commercial sources; the latter was prepared from 99% isopropanol, by dilution with distilled water.

RESULTS AND DISCUSSION

In order to shorten the period of extraction, temperatures higher than 23° C. (room temperature) were tried. A temperature of 70° C. was finally selected. This was considered the highest temperature advisable to employ with 95% ethyl alcohol which boils at 78.4° C. Slightly higher temperatures could have been used with 99% isopropanol, but preliminary investigations indicated that this would not result in any marked difference in the rate of extraction. Thus, for convenience, 70° C. was used for both solvents.

In Table 1 the color values of several samples of capsicum spices are given for two different extraction procedures both employinig 95% ethanol. One of these is the 17-hour (overnight)-23° C. (room temperature) technique and the other is the procedure employing 3-hour extraction at 70° C. It will be shown later in the discussion that for all practical purposes the latter can be relied on to give complete extraction. Therefore, by comparing the results obtained with these two procedures it is seen that the 17-hour-23° C. method does not always give complete extraction and that the degree of extraction may vary from sample to sample. It is evident that the 17-hour-23° C. extraction procedure is subject to significant error.

TABLE 1
Comparison of extraction procedures

Sample	Lovibond red (solvent: 95% ethanol)	
	17 hour-23° C.	3 hour-70° C.
Chili powder	11.6	12.9
Red pepper	12.7	13.2
Cayenne pepper	13.1	13.4
Chili powder	12.6	14.0
Chili pepper	13.6	14.5
Chili powder	13.4	15.2
Paprika	15.2	16.1
Chili powder	14.9	17.0
Chili pepper	16.0	18.1
Paprika	17.2	18.4
Paprika	19.2	19.7
Chili pepper	18.3	20.3
Chili pepper	21.4	22.7

The rate of extraction of capsicum spices at 70° C. over a period of 1 to 6 hours is illustrated in Figure 1. For this experiment, samples representative of the entire capsicum line were used. This included material

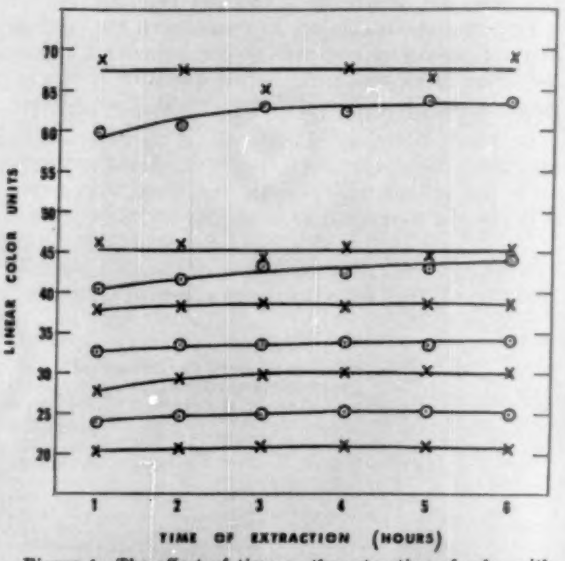

Figure 1. The effect of time on the extraction of color with 99% isopropanol at 70° C. Illustrated are 9 different samples typical of the capsicum spice line. Circles and crosses are used to distinguish points of adjacent plots.

prepared from different types and sources of raw material, as well as samples manufactured to different specifications (mesh, moisture content, surface color, etc.). Since the conclusions arrived at with both 95% ethanol and 99% isopropanol were similar, only the data obtained with the latter are presented in Figure 1.

All of the curves in Figure 1 are relatively flat indicating that most of the pigments were removed during the first hour of extraction. However, in some cases the increase in pigment extraction after the first and even the second hours, although small, was still significant enough to be of concern. At the 3-hour point all of the curves tend to flatten and the color values obtained for this period of extraction are similar to those observed for longer periods. Thus it was concluded that for all practical considerations 3 hours gives complete extraction. This period of time therefore was adopted as standard procedure for determining the color of capsicum extracts.

The selection of 99% isopropanol as a replacement for 95% ethanol was originally motivated by its similarity in chemical structure to ethanol, its availability in relatively pure form, its low cost and the fact that it can be obtained without a special license or permit. It should be noted that this solvent has been in use for a considerable time by some laboratories in the capsicum spice industry and to some extent this would support its suitability for measuring the color of capsicum spices.

The molar absorbancy index, for any specified wavelength and temperature, of a pigment in solution may vary markedly, depending on the nature of the solvent employed. This is illustrated in Table 2 in which absorbancies of equal aliquots of concentrated ethanolic

TABLE 2

Effect of solvent on the absorbancy of extracts of paprika. One (1.0) ml. of concentrated ethanolic (absolute) extract diluted with 50.0 ml. of solvent

Solvent	Absorbancy at 569 mμ (10-cm. light path)	
	Sample A	Sample B
Absolute ethanol	0.433	0.464
95% ethanol	0.479	0.505
99% isopropanol	0.402	0.430
95% isopropanol	0.435	0.458

paprika extracts, diluted with the same volume of different solvents are shown. The results indicate that the amount of water present in a solvent as well as its chemical nature has an effect on the color of a solution.

From the data in Table 2 it is evident that a color value obtained using 99% isopropanol would be significantly different than that determined with 95% ethanol. If both of these values were expressed in the same color units, it is easy to visualize how considerable confusion might arise. In order to avoid this, the authors have reserved the newly-developed linear color units *(3)* for use with 99% isopropanol, while Lovibond units will continue to be employed with 95% ethanol.

In order to study the relationship between linear color units obtained with 99% isopropanol and Lovibond units obtained with 95% ethanol, color values were determined for a large number of samples using both of these solvents with each sample. The results, when plotted, did not correlate well with each other as many points fell either significantly above or below the line of best fit. In the authors' experience this variation was greater than could be attributed to the experimental error normally encountered with the Gentry method when a 3 hour-70° C. extraction is employed. Further study of this plot revealed that a relationship existed between the location of a point and the type of capsicum product which the point represented. On the average the so-called "dark surface-color" samples fell on one side of the line while the "light surface-color" samples fell on the opposite side. This is illustrated in Figure 2,

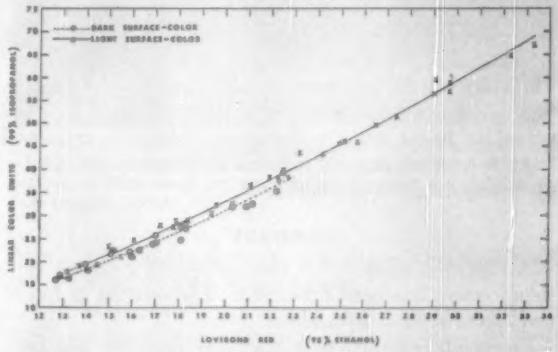

Figure 2. Lovibond red (solvent: 95% ethanol) versus linear color units (solvent: 99% isopropanol). The samples have been divided into two categories — "dark surface-color" and "light surface-color" samples.

where a separate curve has been fitted to the points of each of the two types of samples.

The manufacture of the so-called "dark surface-color" chili peppers and powders involves the application of heat particularly during the mixing operation. The darkening is accompanied by the development of water soluble brown pigments. Experience has led the authors to believe that 95% ethanol extracts a greater proportion of these water-soluble pigments than does 99% isopropanol. This would explain the differences illustrated by the two curves in Figure 2.

Water-soluble brown pigments differ from the carotenoids in that they are artificially produced, are water-soluble, and are brown rather than red in color. They are not important in assaying the quality of capsicum spices and, hence it would be desirable to have a solvent in the capsicum color method which did not extract them. In this respect 99% isopropanol would seem more suitable than 95% ethanol.

In Table 3 the effect of exposing capsicum extracts to radiant energy is shown. It is seen that an intensification of color results. This is the opposite of what

TABLE 3

The effect of radiant energy on the color of capsicum extracts

Sample	Linear color units (solvent: 99% isopropanol)		
	At start	On laboratory bench for 24 hours	
		No light	Normal light
1	30.8	30.6	36.4
2	38.0	38.8	42.6
3	40.8	41.8	48.6
4	29.8	29.4	34.5

might be expected. In fact, to the authors' knowledge this is the first report of such a phenomenon. Two possible explanations are: (1) a rearrangement of pigment-solvent complexes; or (2) elaidinization (isomerization of a *cis* to a *trans* isomer) of the carotenoids. Further studies of this effect might reveal some clue to the physiological role of the carotenoids.

The results in Table 3 illustrate the importance of keeping capsicum extracts in the dark during extraction and prior to being analyzed.

LINEAR COLOR METHOD

This method measures the extractable color of capsicum spices. Extracts are prepared by treating 0.100 g. of capsicum spice with 50.0 ml. of 99% isopropanol for 3 hours at 70° ± 1° C. (See Methods and Materials). The color of the extracts is measured by the Gentry Method *(2)* and the Gentry units thus obtained are converted to linear color units using Figure 5, reference *(3)*. A convenient table for this conversion is available upon request from the authors.

SUMMARY

A modified method for measuring the color of capsicum spices has been presented. The method as modified offers several advantages.

Overnight extraction at room temperature has been replaced by a 3-hour extraction at 70° C. This latter procedure eliminates the possibility of incomplete extraction and also makes the results available in a shorter period of time.

Ethanol (95%) has been replaced by 99% isopropanol.

A linear color scale *(3)* has been substituted for the non-linear Lovibond scale.

An intensification of the color of extracts of capsicum spices when exposed to radiant energy has been observed. It is therefore important to keep extracts in the dark prior to measuring their color.

Acknowledgments

The authors wiish to express their appreciation to Mrs. Susan Peters and Elsebeth Anderson and to Mr. Jack Stubblefield for their assistance in carrying out many of the determinations required in this investigation.

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The Use of Organic Reductants in the Canning of Luncheon Meat[a]

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(Manuscript received June 21, 1956)

Cured luncheon meat packed in the usual six- and eight-pound cans occasionally develops during normal cold storage a brown or greenish-brown discoloration at areas contiguous to the sideseam or to the areas at which the inner surface of key-opening cans has been "scored" to facilitate opening the cans. Figure 1 contrasts the spectral reflectance of a typical discolored area with the reflectance of the normal red surface of the cured meat. These curves were obtained with a General Electric recording spectrophotometer.

Experimental packs involving variations in preparation, curing, and canning of the meat have shown that the discoloration can be minimized by using a minimum concentration of nitrite in the curing mixture. The literature indicates that while sodium nitrite is useful as a source of nitric oxide, which is the actual curing agent *(10)*, sodium nitrite is also capable of oxidizing the natural red meat pigment myoglobin to the brown derivative metmyoglobin. The corresponding oxidation of the blood pigment hemoglobin is subject to catalysis by certain heavy metal ions including those of iron and copper *(12)*. In so far as the chemistry of the heated pigment of the canned product is comparable to that of the unheated pigment discussed in the literature, these facts lead to the theory that the discoloration described is produced by the action of sodium nitrite on the meat pigment and that the discoloration is, at least in part, an oxidized form of the meat pigment, the oxidation being catalysed by iron ions from the can wall.

It was discovered in this laboratory some five years ago that in the commercial packing of luncheon meat the discoloration will be practically eliminated if the meat is packed in a can which has a small square of aluminum welded to the inside of one end. Figure 2 illustrates the discoloration as it is encountered commercially and also shows the effectiveness of the aluminum in preventing it. The samples were packed under conditions so controlled as to give a valid comparison.

During the past 3 or 4 years a number of workers in the meat industry have ascertained that use of ascorbic acid as a component of the curing mixture may confer decidedly beneficial results. For example, Brockmann and Morse *(3)*, using wieners as an essentially homogeneous type of meat product, were able to demonstrate the improved interior color attained by its use. Use of ascorbic acid or sodium ascorbate to attain these

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Mo., June 12, 1956.

benefits is now permitted under food standards and regulations *(9)*. In some of the earlier investigations along this line principal emphasis was placed upon the ability of ascorbic acid to reduce the brown metmyoglobin back to the original red myoglobin, but as shown by Hollenbeck and Monahan *(5)* it is more important

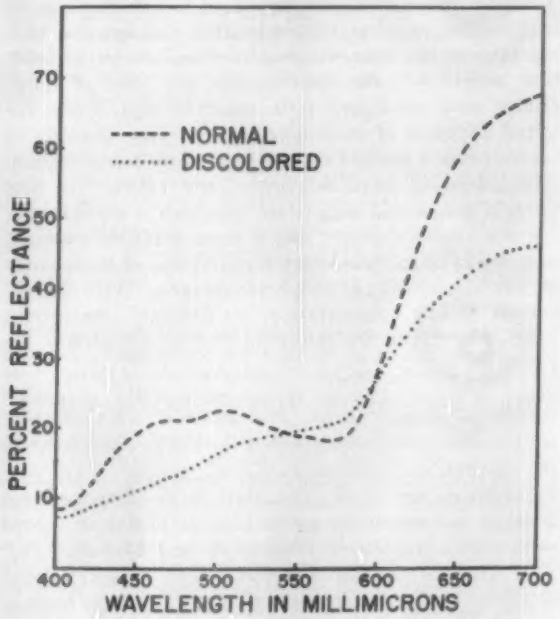

Figure 1. Spectral reflectance of normal and discolored meat.

that ascorbic acid be capable of reducing nitrite ion directly to nitric oxide:

$$\text{I. } 2\,NO_2^- + C_6H_8O_6 = 2\,NO + C_6H_6O_6 + 2\,OH^-$$

The ascorbic acid is oxidized to dehydroascorbic acid. It will be seen that the yield of nitric oxide is twice that obtainable by the non-reductive hydrolysis of nitrite ion:

$$\text{II. } 2\,NO_2^- + H_2O = NO + NO_2 + 2\,OH^-$$

so that by the use of ascorbic acid the curing effectiveness of nitrite theoretically is doubled while the formation of metmyoglobin, due to oxidation by nitrite, is prevented.

None of the published work on the benefits of ascorbic acid in the curing of meat has dealt with canned meat. It was of interest therefore to determine whether this reductant, dispersed in the meat itself, would function in the same manner as the aluminum inserts in preventing the localized discolorations encountered on specific surface areas of canned luncheon meat. The investigation was also carried further, to ascertain whether reductone would function in this manner. Reductone is a substance having an enediol structure analogous to that of ascorbic acid. It can be prepared from glucose by alkaline treatment, and resembles ascorbic acid in its reaction with 2,6-dichlorophenolindophenol. In a patented procedure, Hollenbeck *(4)*

Figure 2. Discoloration as it sometimes occurs commercially on the meat along the sideseam of the can (left). The discoloration is eliminated by the aluminum anode shown with the two samples on the right.

claims that such enediols, as well as ascorbic acid itself, are beneficial in the curing of meat.

In the present work small experimental packs of luncheon meat have been made in glass jars. In most of the jars strips of tinplate, and in a few cases strips of surface-oxidized copper, were so inserted as to be visible through the walls of the container. In each case the metal strip was wrapped in parchment paper, in view of the fact that in the commercial procedure the loaf of luncheon meat is usually so wrapped before packing in cans. After a variable period of the customary cold storage, the typical discoloration appeared radiating from the edges of both types of metal strips in such a way as to be reasonably ascribed to the diffusion of metal ions through the paper and into nearby surface areas of the meat. The phenomenon as it is encountered in commercial packs has this same characteristic; the discoloration in this case appears within the parchment wrapping and upon the meat rather than outside the wrapping and upon the can wall.

Figure 3A illustrates the discoloration encountered in these experimental packs with the tinplate strips when no organic reductant was used. Figure 3B illustrates the protective effect of ascorbic acid and Figure 3C the protective effect of reductone. The oxidized copper strips produced a discoloration similar to that shown in Figure 3A in meat which did not contain any reductant. In making these photographs the glass jars were cut longitudinally on a glass-cutting wheel so that the block of meat could be removed without distortion. The metal strip and its parchment wrapping were then removed. This removal from the jar is not necessary for visual inspection of the samples themselves, but it was imperative for black and white reproduction in order to illustrate at all adequately the marked contrast which exists between the red meat and the brown discoloration.

Three such experimental packs were made involving the use of ascorbic acid, and affording a total of 80

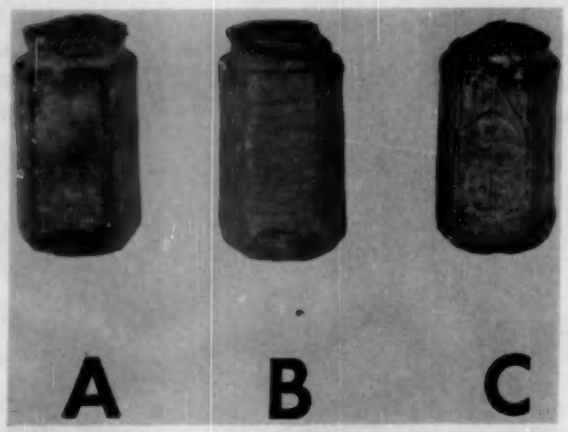

Figure 3. Experimental samples of luncheon meat packed with tin plate strips.
A. Discoloration in the absence of a reductant.
B. Showing the protective effect of ascorbic acid.
C. Showing the protective effect of reductone.

comparison pairs by which to judge the efficacy of ascorbic acid in preventing discoloration. Figure 3B is typical of 70 of the samples containing ascorbic acid; in the other 10 such samples slight discoloration was present. Reductone, as prepared by the method of von Euler and Martius *(11)*, was used in only two of these packs. In the first of these two packs the substance was not well purified. The impure reductone was found to prevent the specific localized discoloration well enough, but to cause a general browning of the entire contents of the container. In the second of the reductone packs the substance was well purified, and Figure 3C is typical of the 20 samples of this pack. In none of these 20 samples did the reductone fail to prevent the discoloration, and no general browning was observed. The discoloration catalyzed by copper is more reddish and more diffuse than that caused by the presence of tinplate, and it appears only when the surface of the copper strip has been oxidized before introduction into the container.

Since the incorporation of an organic reductant into the meat thus accomplishes the same beneficial result as the attachment of aluminum inserts to the inner wall of the can, it is natural to wonder whether the mechanism of action is the same in the two cases. At first thought one may suppose that the aluminum insert, as a sacrificial anodic area, is acting primarily to minimize the attack on the can wall which causes the introduction of catalytically active ferrous ions at the critical areas. And since ascorbic acid demonstrably reduces nitrite directly, one may be led to attribute its beneficial effect primarily to this mechanism rather than to protection of the can wall against corrosion. However, both remedial measures are essentially reducing in their effect and in the absence of evidence it is quite possible that in each case both mechanisms are involved to some extent.

When nitric oxide is liberated from any source in the presence of meat, it is stabilized against oxidation to a considerable extent by its reaction with myoglobin to form the cured-meat pigment complex. This is indicated by the fact that an official A. O. A. C. analytical method exists *(1)* for the determination of excess nitrite in cured meat, and this procedure involves no particular precautions for the exclusion of air. However, a different situation exists when an attempt is made to study the interaction of nitrite with ascorbic acid (Equation I above) in simple aqueous solution. Along with the present work with meat some exploratory experiments were carried out to study this reaction with reactants at low concentration in phosphate buffer solution at pH 6.5, the approximate pH level of meat. Under such conditions it is observed that, while the initial additions of ascorbic acid to a given quantity of nitrite cause a marked decrease in nitrite concentration, later additions have relatively little effect. At first thought this would suggest an approach to equilibrium, but the evidence shows that a more probable explanation lies in an extraordinary sensitiveness of this system to interaction with atmospheric oxygen. With the reactants at low concentration, no ordinary precautions taken to exclude air suffice to repress completely the reaction:

$$\text{III. } 2\,NO + \tfrac{1}{2}\,O_2 + H_2O = 2\,NO_2^- + 2\,H^+$$

which continually re-establishes the nitrite content while the ascorbic acid continues to be oxidized. Our own experiments are briefly described in the Experimental Section, but the above generalization is also in accord with certain results of Hollenbeck and Monahan *(6)*, who also ascribe an important role to atmospheric oxygen. In a pickling solution at pH 6.0 these authors observed a continuing decrease in ascorbic acid content, reaching zero in 14 days, while the measured nitrite content remained unchanged. Lugg *(8)* measured the ascorbic acid consumed during a 5-minute period at room temperature as a function of the nitrite content also present in buffer solutions of pH 1.5. There was a correlation; the higher the nitrite, the greater the ascorbic acid consumption. But a computation based upon his data shows that about five times as much ascorbic acid is consumed in this short period as could be oxidized by all the nitrite present, reacting according to Equation I. This shows that atmospheric oxygen was a very important factor in his experiments. Finally Lemoigne, Monguillon and Des Vaux *(7)*, who worked in a closed system to avoid the loss of nitric oxide as a gas, believe that, while nitrous acid by itself reacts only slowly with oxygen, the addition of ascorbic acid brings about a coupled oxidation to nitrate. There would appear to be need for a careful analytical study of this system, but in the meantime the indications are that the benefits of ascorbic acid in the curing and processing of meat are not fully realizable unless all reasonable precautions are taken to exclude oxygen during the curing and packing procedures.

EXPERIMENTAL

Meat packing procedure. Fresh pork shoulder was ground through a quarter-inch grinding plate. The meat was divided into lots of 15 pounds and each lot was vacuum mixed for 5 minutes with curing salts of the following composition: sodium nitrate, 11.7 g.; sodium nitrite, 1.1 g.; sucrose, 133 g.; salt, 200 g. Some of the 15 pound lots also contained 10.6 g. of

ascorbic acid[b]; other lots contained reductone in an amount equivalent to 10.6 g. of ascorbic acid as determined by titration with indophenol. The meat was cured overnight at approximately 35° F. The next day the meat was vacuum mixed again and stuffed into 4 oz. glass jars containing a metal strip as previously described. The jars were closed under a 20-inch vacuum and processed 4 hours at 165° F. The jars were then water cooled and stored at 40° F.

Nitrite analyses were run using the sulfanilic acid-alpha naphthylamine hydrochloride method *(1)*. The 2 reagents were added simultaneously. Ascorbic acid and reductone were estimated by titration with indophenol reagent *(2)*. Results are shown in Table 1. Initially, 162 p.p.m. of sodium nitrite were added to meat in each lot.

TABLE 1

Reductant added	Storage period	Nitrite recovered	Reductant recovered
None	2 weeks	50 p.p.m.	.....
1560 p.p.m. ascorbic acid	2 weeks	5 p.p.m.	1200 p.p.m.
None	29 weeks	3.8 p.p.m.	.....
1560 p.p.m. ascorbic acid	29 weeks	0.1 p.p.m.	830 p.p.m.
780 p.p.m. reductone	4 weeks	6 p.p.m.	250 p.p.m.

Nitrite-ascorbic acid reaction in aqueous solution. 1.0×10^{-4} grams of sodium nitrite and 1.25×10^{-3} grams of ascorbic acid were allowed to react in buffered solution (pH 6.5) using precautions to minimize exposure to air. The buffer was preboiled and cooled under nitrogen, and the reagents were added against effluent nitrogen. The proportion of ascorbic acid, relative to the nitrite, is ten times the stoichiometric proportion expressed by Equation I. After various reaction times samples were withdrawn against effluent nitrogen and analyzed for nitrite. Table 2 shows that the nitrite decreased within 5 minutes to a value which remained practically constant for an hour. Although the system remained tightly stoppered overnight, the nitrite content during the ensuing 16-hour interval increased nearly to the original value, with insignificant further increase on opening the system to the air.

A similar experiment was carried out in which the reaction mixture was analyzed for ascorbic acid instead of nitrite. The data are shown in Table 3. Here the ascorbic acid decreased

TABLE 2

Sodium nitrite present after various reaction times with ascorbic acid

Reaction time	Micromoles of nitrite present per 100 ml.
.....	1.45
5 min.	0.57
8 min.	0.63
32 min.	0.61
65 min.	0.63
17 hours	1.43
17.5 hours (After addition of air)	1.45

TABLE 3

Ascorbic acid remaining after various reaction times with sodium nitrite

Reaction time	Micromoles of ascorbic acid present per 100 ml.
.....	7.10
6 min.	6.59
9 min.	6.02
32 min.	6.31
61 min.	5.96
17 hours	3.01

within 6 minutes to a value which remained constant for an hour, but a large further decrease took place on standing overnight. The implication that a residual trace of oxygen is an important factor in this situation is obvious, yet anomalies remain which cannot be explained at present.

[b] This is more than the present legal limit for ascorbic acid additions to meat, but this work was started before regulations had been established.

SUMMARY

Canned luncheon meat packed in the usual six and eight pound cans occasionally develops brown discoloration on specific localized areas on the surface of the loaf of meat. Much of this may be due to oxidation of the meat pigment by nitrite, a reaction which is catalysed by iron ions. The trouble can be minimized by packing the meat in a can which has a small piece of metallic aluminum welded to the inside of one end.

The meat industry has ascertained that ascorbic acid is helpful in the curing of meat for reasons based on its ability to reduce nitrite ion to nitric oxide during the curing process. In the present work it has been found that the use of ascorbic acid during curing yields a product which when canned is much less likely to develop localized discoloration. The use of reductone instead of ascorbic acid can give similarly beneficial results. The complete mechanism of the reaction between ascorbic acid and sodium nitrite is imperfectly understood at present, but evidence exists to indicate that this system is extremely susceptible to influence by oxygen. This is important not only in the curing of meat containing ascorbic acid but also in the analysis of meat to which ascorbic acid and nitrite have been added.

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Integrated Quality Control[a]

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(Manuscript received September 14, 1956)

GREAT TECHNOLOGICAL ADVANCES have been made by the food processing industry during the last few years. Now, with radiation sterilization on the horizon, it seems probable that the future will show yet greater progress. In advertising and sales, too, the industry has been pushing forward—keeping in step with the modern tempo of business and industrial life in other fields. But, what about quality control procedures in the food field? Are they as dynamic as they should be? Are they still being operated in the shadow of a kind of negative quality control? That is, are we constantly striving by inspection methods to detect poor quality and thus to prevent the substandard product from reaching the consumer? Are we calling this negative approach, necessary as it is, quality control? You cannot "inspect" bad quality out; you must *build* good quality in. We must develop positive quality control. We must apply positive thinking to quality control in order to foresee and thus to avoid some of the pitfalls that result in poor quality.

Integrated quality control. By uniting quality control functions and consolidating them in a common cause, we can obtain lasting and long range benefits. Webster foreshadows such a process when he defines the term "Integrate"—"to unite or become united so as to form a perfect whole." We can put the word to work in the concept: *Integrated Quality Control.* Here is a functional outline for Integrated Quality Control:

1. Raw Material Quality Control.
2. Process Quality Control.
3. Product Quality Control.
4. Production Supervisor Training to Attain and Maintain Quality Control.
5. Public Relations to Facilitate Quality Control.

These five functions are responsibilities of the head of the quality control department either in whole or in part. Where the responsibility is joint, he must coordinate his activities with those of the other department concerned. Although this discussion will be centered around bakery operations, the principles can be applied to any food industry. Product quality control in a bakery is rather difficult because of the short shelf life of the product. If batches of bread, for instance, were to be kept long enough to be exhaustively sampled and checked, either the bread would be stale before it reached the consumer or the quality control staff would have to be so large that it would be out of proportion in size and economy with the production department. Consequently, we cannot depend too much on the inspection of the finished product; we must assure uniform good quality by making use of control measures on raw materials and processes.

Raw material control. The first phase of integrated quality control, Raw Material Control, is the responsibility of the head of the chemical laboratory. It is necessary that he be directly accountable to the quality control head. His phase of integrated quality control can be sub-divided as follows:

1. Development of chemical standards for ingredients.
2. Development of sanitation standards for ingredients.
3. Checking incoming ingredients against specifications.
4. Checking new developments in ingredients.

Developing chemical and physical standards for ingredients is the very backbone of this phase of quality control. These standards consist mainly of chemical and physical specifications for the various ingredients used. To mention a few of them, together with factors of concern, we have:

Flour: Moisture, ash, protein content.
Frozen Eggs: Color, solids, bacteria count
Frozen Fruit: Color, solids
Fat: Peroxide number, AOM Hours

Development of standards must be continuous. It must be pointed toward finding methods of analysis which stress speed but which, at the same time, can be used as standards of quality for a specific purpose. A good example of this is the use of the phloroglucinol test, commonly known as the modified "Kries" Test *(2, 4)*, employed in the acceptance or rejection of bulk fat shipments.

By using the phloroglucinol test, the laboratory is able to develop a working correlation between phloroglucinol color and age of the bulk fats that the plant uses. Samples of fat are taken from the bulk cars as soon as they arrive at the plant. The car is not unloaded until the phloroglucinol test is run and the color shown to be normal. In the event that the phloroglucinol color is dark, a peroxide number is run as a re-check on the findings.

In developing sanitation standards for ingredients, the fragment count and observations on the amount of extraneous matter in flour and corn meal are primary concerns. However, other ingredients and other factors cannot be overlooked. For example, our honey and syrup purity standards result from a quest for a method to detect quickly the residues in syrups and honey which were causing us trouble. We wished to be able to sample and check these ingredients before the product was unloaded from the shippers' trucks. The method we came up with is an adaptation of the scorched particle test used for dry milk *(2)*. In operation it is very simple and very fast: Merely weigh 100 g. of the sample into a tared pint jar, add hot water (140° F.) to the syrup, and shake until the syrup is well dissolved. Remove the cover, check the aroma, and pour the contents into the filtering funnel. When filtration is complete, remove the filter pad and compare with the standards. From the amount of sediment found, a series of standards was developed. This procedure *(3)*, as well as our actual standards, was issued

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 12, 1956.

to our honey and syrup suppliers. Since that time we have had little trouble with residues, either in honey, molasses, or syrup.

Raw Material Control also includes the routine checking of incoming ingredients against the established specifications and sanitation standards. There is very little glamour in this operation—just routine work. It is nonetheless essential. The crucial requirements for this type of checking is proper sampling. One of the most difficult of all sampling tasks is that used for bulk flour.

Figure 1 is a cut-away view of a bulk flour car. Such a car holds approximately 80,000 pounds of flour. After

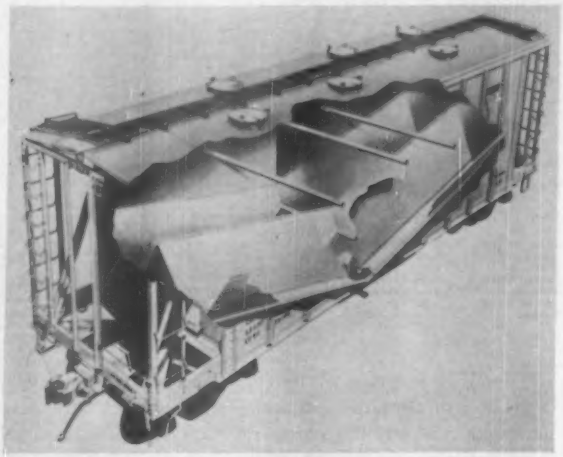

Figure 1. Cut-away view—bulk flour car.

the cars arrive on the siding, each one must be properly sampled and checked. Figure 2 is a composite view of our bulk flour sampling equipment. The large trier, *a* (Fig. 2) is used to probe the car, from on top, through the hatches. Approximately 8 to 10 probes are made from each hatch, a total of 48 to 60 probes. The "probes" are next mixed together to form a composite sample, shown as *b* (Fig. 2). The long-stem thermometer, *c* (Fig. 2) is used to take the temperature of the flour in the bulk cars on arrival. The temperature of the flour in the bulk cars tells us a little about the past history of the flour; if the flour is hot it may have been damaged. The importance of proper sampling should be heavily stressed. Sampling must be carefully watched, particularly when the sampling is done by members of the production or maintenance departments. In some cases, they do not realize the importance of proper sampling.

Figure 2. Composite view. Bulk flour sampling equipment.

No discussion of Raw Material Control would be complete without some mention of new developments in ingredients. Members of the quality control laboratory staff can keep abreast of any new developments in ingredients by keeping in close touch with the technical departments of their suppliers. Laboratory personnel who take an active part in both the local and national affairs of such technical societies as the Institute of Food Technologists and the American Association of Cereal Chemists have an added resource. Contacts gained through these associations may be invaluable in development work.

Process quality control. Now let us turn to the second phase of integrated quality control—Process Quality Control. This second phase can be broken down as follows:

1. Scoring products to assist in determining production errors.
2. Checking efficiency of production equipment.
3. Sanitation inspection and extraneous matter analysis.
4. Periodic check of all formulas against master formulas.

One of the most important means of process quality control in bake shop operation is scoring the finished product in order to assist the production department in determining production errors. It is in this area of quality control where the director of production and the head of the quality control department must coordinate their activities most closely. Since the scoring is done by master craftsmen and under the direction of Quality Control, the scores must be accepted with good grace by the production department. By the same token, the scoring must be on a constructive basis. The production department is obligated, of course, to make every effort to correct the deficiencies found. It should be obvious that the head of Quality Control cannot be under the direction of production. He must be part of top management.

The second function of Process Quality Control is checking the efficiency of production equipment. It is here that the quality control department can be of real service to the production and engineering departments by checking such items as divider efficiency and "bake-out" loss, to mention but a few of the critical points.

The third important function of Process Quality Control is the monthly sanitation inspection. This inspection is a 4- or 5-hour affair in which the plant manager and his head sanitarian must accompany the quality control inspector on his inspection. The various plants are rated on a standard inspection form in which basic sanitation as well as proper housekeeping is stressed. This inspection is patterned after a typical Food and Drug inspection in that it is unannounced and may occur at almost any time of the day or any day of the week. A report of the findings is written. Any discrepancies found must be corrected within an allotted time. After this, the plant is re-inspected. To back up this inspection program, an extraneous matter analysis is made monthly on samples of baked products from each plant. Extraneous matter such as insect fragments or rodent hairs, if found in the products, subjects the plant to an immediate inspection. At the time of this plant inspection, additional samples of baked products

as well as samples of ingredients are picked up and further checks are run on them.

The final function of Process Quality Control is a periodic check of all plant formula against the master formula issued by headquarters. This is not done in the plant office by looking at the file copy, but by checking the weighing and mixing room cards in actual use in the plant. Any discrepancies found are investigated on the spot.

Product quality control. Product Quality Control, third phase in the general picture, is, of course, the ace feature of the entire system. We subdivide this phase as follows:

1. Scoring products to determine quality from the consumer standpoint.
2. Comparatice scoring.
3. Development of new quality items.

In scoring, we stress the consumers' viewpoint. If we please *her,* all is well. The scoring forms which we use were developed with this in mind. Hundreds of homemakers in Philadelphia and vicinity were interviewed and many panels used in an attempt to find out just what our customer considers important in baked product quality. These women were shown samples of bread, cake, and coffee cake in which certain processing techniques were varied. They were asked to choose what they liked and what they did not like—and why. They were encouraged to make any comments they deemed fitting. In this manner, the following product scores were developed:

1. Bread and Roll Score (Figure 3)
2. Coffee Cake Score (Figure 4)
3. Cake Score (Figure 5)

Note the fact that these scores include the package. For many years the manufacturers of bakery products failed to realize that the package is an integral part of the product. In the case of cakes and sweet goods it should also be noted that the topping (icing) as well as the filling are given an important place in the score. The baked products are scored by a home economist. They are scored from her viewpoint, not from a production viewpoint. She represents the consumer and pays no attention to production problems.

The disposition of these scores is as follows: the original goes to the bakery manager with copies to the director of bakeries as well as to the general production manager.

Now let us back-track to that function of Process Quality Control where we discussed scoring. After the home economist has finished her scoring, the product is examined by a craftsman. The craftsman who examines the product, notes any observations under the "remarks" column. He does not change the scores in any way, but helps to interpret them for the bakery manager.

These score sheets are also used in the second function of product quality control which is: comparative scoring. That is, they are used when we score our competition merchandise alongside our own. We do this regularly. This is a very important function and aids greatly in keeping our quality in line.

Bread and Roll Quality Report

CHARACTERISTIC	PERFECT SCORE	PRODUCT SCORE	PENALIZED FOR:				TYPE
PACKAGE Condition	8		Soiled Torn Wrinkled		Crushed Not Neat		RECEIVED FROM
Wrap	8		Loose Tight Bad Seal		End Label Overlap		DATE RECEIVED
Symmetry (Bread Only)	4		Low Flat Uneven Crushed		Deformed Shrunken Burst		DATE BAKED
PRODUCT Bake and External Surface	12		Light Dark Dull Smoked Soiled		Not Uniform Burst Greasy Sporty		DATE SCORED SCORED BY CHECKED BY
Volume	8		Too Large		Too Small		ACTUAL WEIGHT ____OZ.
Slice Symmetry or Roll Symmetry	4 8		Crushed Shrunken Uneven Low Side		Heel Thick Thin Irregular		LABEL WEIGHT ____OZ.
Crust Character	8		Thick Tough Hard		Cracked Wrinkled		DIFFERENCE ____OZ.
TOTAL EXTERNAL	44						REMARKS:
Grain	12		Coarse Not Uniform Thick Cell Walls		Open Holes		
Texture	12		Compact Lumpy Core Crumbly		Harsh Doughy Dry		
Crumb Color	4		Dark Light Streaky		Dull Gray		
Aroma	8		Lack of Strong Sour Off		Musty Foreign Sharp		
Taste	16		Flat Salty Sour Foreign Off		Strong Musty Unpleasant Aftertaste		
Mastication	8		Doughy Dry		Tough Gummy		
TOTAL INTERNAL	56		Explanations: T – Top B – Bottom S – Side		Overlap Inches		
TOTAL SCORE	100						

Figure 3.

The final function of Product Quality Control concerns the development of new items. When any new item is developed, it is scored on these same forms. Not only is the newly developed product scored during its

Sweet Goods Quality Report

ACTUAL WEIGHT	OZ.
LABEL WEIGHT	OZ.
DIFFERENCE	OZ.

PRODUCT				NUMBER	CODE
RECEIVED FROM	DATE RECEIVED	DATE BAKED	DATE SCORED	SCORED BY	
				CHECKED BY	

CHARACTERISTIC	PERFECT SCORE	PRODUCT SCORE	PENALIZED FOR:					
PACKAGE Condition	8		Wrinkled Grease Spotted		Crushed Topping Smeared		Torn Soiled	
Wrap	4		Loose Tight		Label Overlap		End Seal	
PRODUCT Symmetry	4		Crushed Low		Uneven Flat		Shrunken	
Volume	3		Too Large		Too Small			
Bake and External Surface	4		Light Dark Not Uniform		Soiled Sporty Smoked		Dull Burnt	
Crust Character	3		Thick Tough		Hard Pasty		Soggy	
TOTAL EXTERNAL	26							
Grain	8		Coarse Holes		Not Uniform Thick Cell Walls		Open	
Texture	10		Dry Doughy		Harsh Lumpy		Soggy	
Crumb Color	3		Light Not Uniform		Dark		Dull	
Aroma	4		Lack of Strong		Sour Foreign		Sharp	
Eating Quality of Product	20		Doughy Dry Flat		Soggy Too Sweet Tough		Unpleasant Aftertaste	
TOTAL INTERNAL	42							
TOPPING Appearance and Texture	TOPPED ONLY 12	TOPPED FILLED 8	Smeared Sticky Pasty		Dry – Wet Hard Crumbly		Not Uniform Color	
Distribution	8	8	Lack of		Too Much		Uneven	
Eating Quality	10	4	Flat Too Sweet		Gritty Dry		Tough	
TOTAL TOPPING	30	20						
FILLING Appearance and Texture	3		Not Uniform Dry Color		Too Moist Raw Sucked In		Hard Lumpy	
Distribution	4		Lack of		Too Much		Uneven	
Eating Quality	3		Flat Sour Dry		Foreign Too Sweet		Strong Greasy	
TOTAL FILLING	10		REMARKS:					
TOTAL SCORE	100							

Explanation: T = Top S = Side B = Bottom

Figure 4.

Cake Quality Report

ACTUAL WEIGHT	OZ.	PRODUCT				NUMBER	CODE
LABEL WEIGHT	OZ.	RECEIVED FROM	DATE RECEIVED	DATE BAKED	DATE SCORED	SCORED BY	
DIFFERENCE	OZ.					CHECKED BY	

CHARACTERISTIC	PERFECT SCORE	PRODUCT SCORE	PENALIZED FOR:					
PACKAGE Condition	6		Icing Smeared / Crushed		Torn / Wrinkled		Grease Spotted / Soiled	
Wrap	6		Loose / Tight		End Seal		Label	
PRODUCT Symmetry	4		Low Side / Uneven		Low End / Sunken		Crushed	
Volume	5		Too Small		Too Large			
Bake and External Surface	UNICED 15	ICED 5	Light / Dark / Not Uniform		Dull / Burnt / Streaked		Soiled / Greasy	
Crust Character	8	3	Thick / Tough		Cracked / Peels		Too Moist	
TOTAL EXTERNAL	40	28						
Grain	7		Coarse / Holes		Not Uniform / Open		Tunnels / Thick Cell Walls	
Texture	13		Dry / Harsh / Doughy		Too Moist / Lumpy / Not Tender		Crumbly / Too Compact	
Crumb Color	5		Light / Dark		Dull / Oil		Not Uniform	
Aroma	8	3	Lack of / Strong		Foreign / Eggy		Artificial	
Eating Quality of Product	30	30	Flat / Gummy / Dry		Tough / Artificial / Too Sweet		Unpleasant / Aftertaste	
TOTAL INTERNAL	60	45						
ICING Appearance and Texture	ICED ONLY 15	ICED FILLED 10	Smeared / Sticky / Peels Off / Wet		Grainy / Hard / Cracked / Not Uniform		Too Soft / Color	
Distribution	9	6	Too Much		Lack of		Uneven	
Eating Quality	6	4	Flat / Gritty		Too Sweet / Strong		Bitter	
TOTAL ICING	30	20						
FILLING Distribution	4		Too Much		Lack of		Uneven	
Appearance and Texture	3		Grainy / Not Uniform		Color		Soaked In	
Eating Quality	3		Flat / Too Sweet		Gritty / Strong		Bitter	
TOTAL FILLING	10		REMARKS:					
TOTAL SCORE	100							

Explanation: T = Top B = Bottom S = Side

Figure 5.

development, but also daily during the first several weeks of production which is the critical time for any new item. In order to aid in comparison during the transition period, a supply of a newly developed product is kept in the laboratory for checks against the same items produced in quantity in the plant. In some cases photographs are also used.

Production supervisor training. In line with the policy of building good quality *in*, we consider production personnel training as one of the best means of doing this. If the production supervisors are thoroughly indoctrinated in the importance of quality and how they fit into the over-all quality picture, you have a much better chance of attaining your goal than by inspection and scoring alone. Both inspection and scoring are very important, however, from the follow-through standpoint and for that reason cannot be underestimated. Our supervisor training consists of two phases. First, on-the-job training, which is handled in the plant by the production personnel. Second, classroom work, which is handled by the quality control department. These classes are held on a weekly basis, on a three-year plan. The course is aimed at covering in that time the main concepts of our production in both the technical and practical fields. Another part of our supervisor training program is aimed at training new personnel to become supervisors; it is a prequisite to the advance program described above and deals mainly with theory and fundamentals. It is a two-year program and, like the one above, runs concurrently with on-the-job training. Still another part of our supervisor training is the preparation and issue of technical bulletins. These bulletins are designed primarily for the use of the plant manager. They are issued from time to time or at the request of the plant manager. In the past, they have covered such topics as:

1. Explanation of chemical analysis of flour.
2. Explanation of scoring system.
3. Sampling and inspection techniques.
4. Pan preparation and general cleaning.

These bulletins have become very popular with the plant managers and are usually kept in a binder for ready reference.

Public relations. Fifth and last phase of integrated quality control, as we see it, is public relations. The over-all aspect of public relations is, of course, handled by that department. There still is, however, a great deal that the quality control department can do. They can maintain a very close working relationship, completely ethical, with the local branch of the Food and Drug Office as well as with the city and state officials concerned with these matters. We send our laboratory technicians to the local Food and Drug laboratories for training in the analysis of filth and extraneous matter. These agencies have, in turn, sent some of their technicians to our laboratory for a study of a rapid method of vitamin analysis for bread, which we developed, as well as a study of our syrup-testing method. Our Municipal Health Department (Philadelphia) has sent all of its health inspectors to our plant for classes and for practical instruction in bakery sanitation methods. During these sessions, we profited by the broad experiences that some of the inspectors had in other segments of the food industry.

Plant tours for the general public are conducted every Tuesday. These tours are under the auspices of the public relations department. The Quality Control Department also conducts tours—tours for classes from local colleges, usually classes majoring in home economics or business administration. These tours are concluded with a question-and-answer period, conducted over doughnuts and coffee. Some very interesting discussions take place.

In conclusion, it should be stressed that the above approach to quality control just described will work only if the quality control director is part of the top management team. In any organization where either production or sales dominates the picture, this system is doomed.

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Properties of the Synthetic Sweetening Agent, Cyclamate

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(Manuscript received September 14, 1956)

ALTHOUGH A VARIETY OF CHEMICALS other than the carbohydrates have been reported to have a sweet taste, only two synthetic sweetening agents are safe for use in foods and beverages. These two artificial sweetening agents are cyclamate and saccharin. Saccharin, discovered in 1879, has been commercially available since 1900. Its properties and those of the various saccharin salts and other derivatives have been reviewed several times *(5, 11)*. Cyclamate, discovered in 1937, became available in 1950. Several articles describing the use of cyclamate have been published *(3, 6)*, but little has been published about its properties.

Cyclamate[a] is the generic name for the cyclohexylsulfamates. The sodium and calcium salts are commercially available.

Sodium cyclohexylsulfamate is $C_6H_{11}NHSO_3Na$, mol. wt. 201.23. It is a white crystalline powder and is quite stable. It is readily soluble in water, and solutions are quite stable to heat, light and air throughout the pH range 2 to 10.

Calcium cyclohexylsulfamate is $(C_6H_{11}NHSO_3)_2 Ca \cdot 2H_2O$, mol. wt. 432.58. It is also a stable, white crystalline powder. The water of crystallization can be removed by drying at 140° C. for 2 hours. Readily soluble in water, solutions are quite stable to heat, light and air throughout the pH range 2 to 10.

Sweetness factor. Sodium cyclohexylsulfamate was first prepared by Audrieth and Sveda at the University of Illinois in 1937. Its sweet taste, discovered accidentally, was reported by these investigators in their publication of studies on a series of N-substituted sulfamic acids *(1, 2)*.

Audrieth and Sveda prepared N-cyclohexylsulfamic acid and its sodium, ammonium, barium and silver salts. The acid is a white solid melting at 169-170° C.[b] It was described as having a lemon-sour sweetness. In determining the neutral equivalent of the acid by titration with barium hydroxide, the end-point was between pH 7.3 and 7.4, indicating that it is a strong acid. The acid is slowly hydrolyzed by hot water.

All four salts of cyclohexylsulfamic acid were reported to have a sweet taste. Subsequent studies indicate that any N-cyclohexylsulfamate salt is sweet in which the cation does not have an unpleasant taste in itself. Sweetness was determined by dilution to threshold sweetness, and Audrieth and Sveda reported sodium cyclohexylsulfamate to be 71 times as sweet as sugar and ammonium cyclohexylsulfamate to be 36 times as sweet as sugar. Since the barium salt has relatively low solubility and the silver salt is sensitive to light, these two salts were not examined further.

More extensive studies of the sweetness of sodium and calcium cyclamate have been reported by Vincent and co-workers *(17)*. They reported these cyclamates to be 15 to 30 times as sweet as sucrose in aqueous solution, depending upon the concentration. Synthetic sweeteners, in general, seem to exhibit a greater sweetness ratio in dilute solutions than in higher concentrations. The sweetness of cyclamate is subject to a number of variables, and it is more sweet in actual use than the studies of aqueous solutions would indicate. No manufacturer of dietetic foods and beverages has reported cyclamate to be less than 30 times as sweet as sucrose. In general, the sweetness is greater in liquid than in solid foods. The sweetness factor varies with flavors and is greater in fruit flavors than in others. No essential difference between the sweetening potency of sodium and calcium cyclamate has been reported, but a slight difference might be expected from consideration of relative molecular weights.

Both calcium cyclamate and sodium cyclamate are readily soluble in water. The calcium salt has good solubility in aqueous ethyl alcohol and propylene glycol. Neither salt has appreciable solubility in oils or nonpolar solvents. Solubility data are summarized in Table 1. Temperature-solubility curves for sodium cyclamate and calcium cyclamate in water are given in Figures 1 and 2 *(14)*. At room temperature, cyclamate will form approximately a 20% solution, which would provide sweetness well beyond that of a saturated sugar solution. Thus, sweetening concentrations are possible with cyclamate which cannot be attained with sugar.

TABLE 1
Solubility of calcium and sodium cyclamate grams per 100 cc. of solvent at 25° C.

Solvent	Calcium Cyclamate	Sodium Cyclamate
Water, 25° C.	24	21
25% ethanol	25	16
50% ethanol	25	14
75% ethanol	15	1
90% ethanol	2.4	....
Absolute ethanol	1.7	insoluble
Propylene glycol	70	4.3

The titration curve of cyclohexylsulfamic acid with sodium hydroxide shows it to be a strong acid, Figure 3 *(10)*. The half-neutralization point is below pH 1, so that cyclohexylsulfamic acid can be classed with the mineral acids. No cyclamate salt is converted to acid above pH 2, which is an important factor in the stability of cyclamate as a sweetening agent for very acidic foods and beverages. A solution of cyclamate in 6 *N* hydrochloric acid can be heated at boiling for 30 minutes, and only a trace of sulfate is formed.

The cyclohexylsulfamates are readily cleaved by the reducing agent, nitrous acid. An analytical procedure for cyclamate is based on this reaction. A sample estimated to contain about 100 mg. of cyclamate in about 200 cc. of water is cleared of any free sulfate by the

[a] Introduced in 1950 by Abbott Laboratories as Sucaryl®.

[b] Samples of cyclohexylsulfamic acid prepared in our laboratories melted at 180-181° C.

addition of 10 cc. of concentrated hydrochloric acid and 10 cc. of 10% barium chloride solution. After removal of any precipitate, 10 cc. of 10% sodium nitrite solution is added and the solution is digested on a hot plate until the supernatant liquid clears. The precipitate is collected in a tared crucible, dried at 100° C. for 15 min., and weighed. Each milligram of barium sulfate is equivalent to 0.9266 mg. of calcium cyclamate or to 0.8621 mg. of sodium cyclamate.

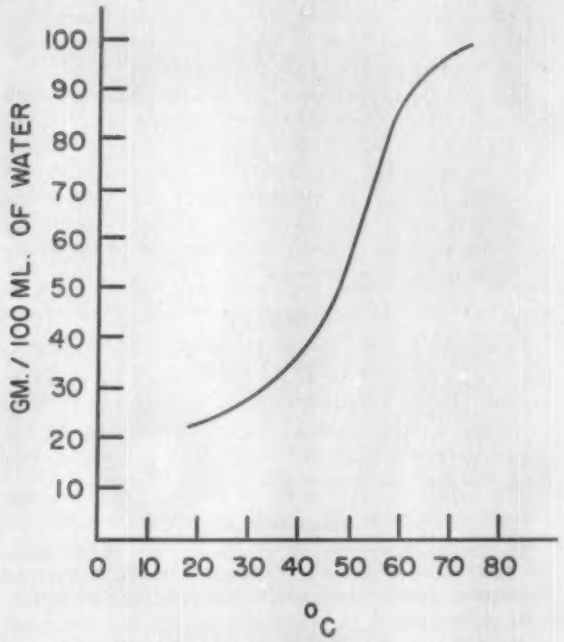

Figure 1. Solubility of calcium cyclamate in water.

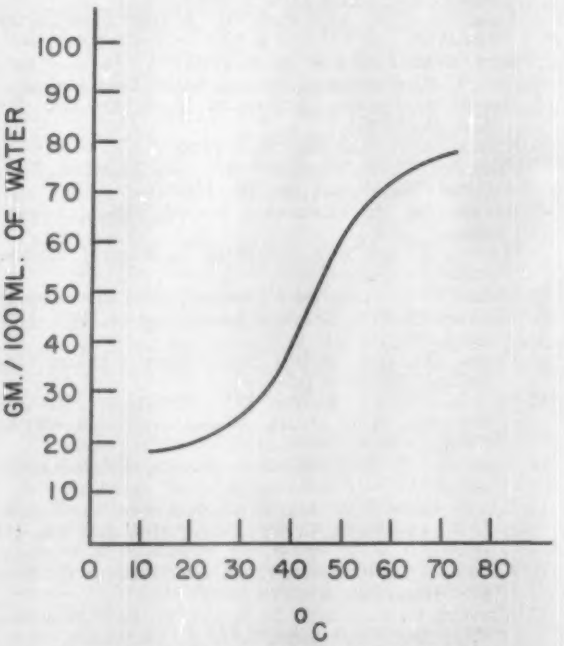

Figure 2. Solubility of sodium cyclamate in water.

Properties and characteristics. The properties of sodium and calcium cyclohexylsulfamate are characteristically those of strong electrolytes. Titration of 5 cc. of 0.1 *N* hydrochloric acid containing 150 mg. of either sodium or calcium cyclamate with sodium hydroxide, Figure 4, shows the salts to be without buffering capacity *(10)*. In this respect they act as sodium chloride would.

Freezing point depression determinations for water containing 0.1 and 0.2 molar sodium cyclohexylsulfamate show that it is 100% ionized at both concentrations. The freezing point depression of 0.08 and 0.11 molar calcium cyclohexylsulfamate indicate that at a 0.1 molar concentration it is partially associated and acts as if it were only 90% ionized *(14)*.

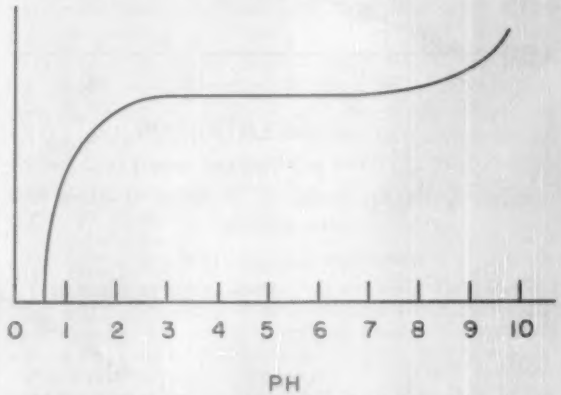

Figure 3. Titration of N-cyclohexylsulfamic acid with sodium hydroxide.

The curves for increase of density and of viscosity with concentration are the same for solutions of either sodium or calcium cyclohexylsulfamate. The increase of density with concentration of either cyclamate is given by Figure 5, and the increase of viscosity with concentration of sodium or calcium cyclamate is given by Figure 6 *(4)*. These properties are radically different from those of a sugar solution of comparable sweetness. Cyclamate solutions are observed to have quite different "body" and "mouth-feel" than sugar solutions as used in foods and beverages.

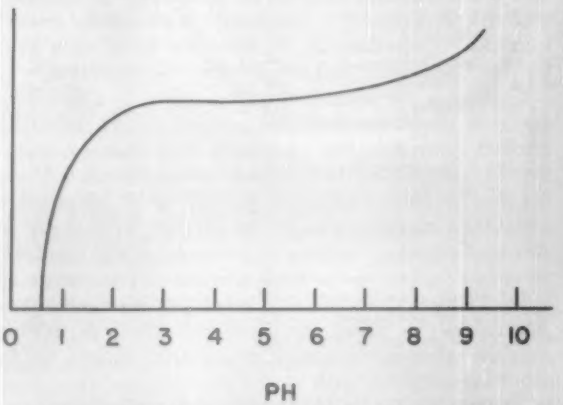

Figure 4. Titration of 15 cc. of 0.1 HCl containing 150 mg. of calcium or sodium cyclamate with sodium hydroxide.

Sodium and calcium cyclohexylsulfamate can be heated to about 500° C. without decomposition. Calcium cyclohexylfamate loses its water of crystallization but undergoes no other change. Cyclamate has none of the caramelization properties of sugars. Cyclamate is quite stable to heat in boiling and baking processes and to friction in machining processes.

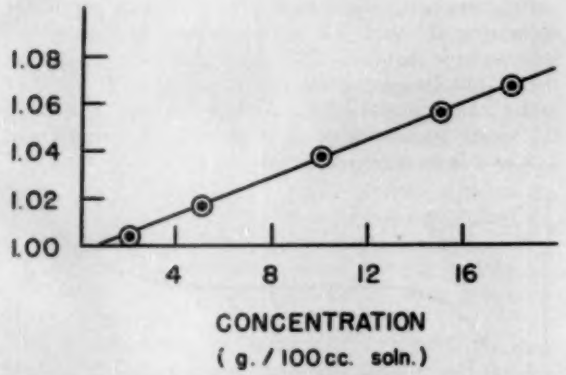

Figure 5. Relative density d_4^{20} of calcium or sodium cyclamate solutions.

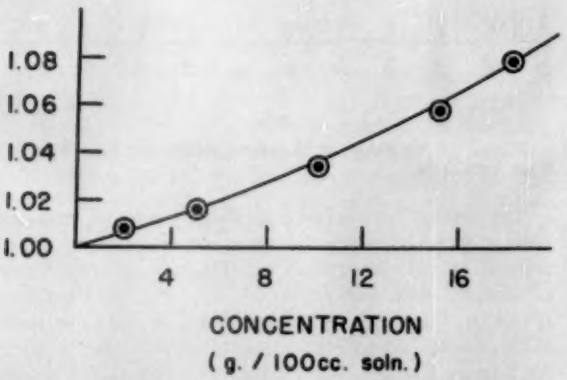

Figure 6. Relative viscosity n/n_o of calcium or sodium cyclamate solutions at 25° C.

A microbial count on several production lot samples of cyclamate calcium showed less than 5 microorganisms per gram *(8)*. Cyclamate is essentially free of microbial contamination. It does not serve as a food for microorganisms and hence cannot be fermented.

Cyclamate has found particular utility as a flavoring agent in pharmaceutical preparations. It is unusually efficient in masking the unpleasant taste of many drugs, such as antibiotics, barbiturates, vitamins, etc. There appears to be a qualitative as well as a quantitative advantage of cyclamate in comparison with sugar in this application. The type of sweetness of the synthetic sweetener seems to be well adapted to counteracting bitter tastes. The relatively small amount needed has advantages in drug preparations, also, permitting smaller volumes of liquids or smaller tablets to be administered.

Pharmacological and clinical studies with cyclamate have established that it is non-toxic. Acute and chronic toxicity and radioactive tracer studies have shown that cyclamate is excreted unchanged and is not stored in the tissues or organs of the animal body *(13, 16)*. A study of several synthetic sweetening agents by the Division of Pharmacology of the Food and Drug Administration also showed cyclamate and saccharin to be non-toxic *(7)*.

Early clinical studies indicated that cyclamate is safe but might exert a mild laxative effect in high doses *(15)*. More extensive studies on this subject show that this effect can be observed only if cyclamate is administered in the solid form in high doses, but not in dissolved form as used in foods and beverages *(9, 12)*.

The general properties of cyclamate compared with those of carbohydrate sweeteners suggest many applications in which factors other than its non-caloric nature might be important. Cyclamate has not been promoted as a food additive for purposes other than sweetening of dietetic foods and beverages. Certain regulatory problems must be clarified to permit use of cyclamate for other technologic reasons.

SUMMARY

Cyclamate has the properties of a strong electrolyte salt. In practice it is 30 or more times as sweet as sucrose. It has excellent stability to heat and to acids or bases. Products containing cyclamate can be expected to behave quite differently than if a sugar were used, although the taste might be quite similar.

Acknowledgments

The cooperation of Dr. W. E. Grundy, Mr. H. S. Miller, Mr. R. U. Robinson, Miss L. F. Dow and Dr. W. B. Brownell in collecting data for this paper is gratefully acknowledged.

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Use of High-Voltage Cathode Rays to Destroy Bacteria of the Salmonella Group In Liquid and Frozen Egg White And Egg White Solids[a, b, c]

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(Manuscript received August 25, 1956)

BACTERIA OF THE SALMONELLA GROUP have been known, for a number of years, to occur in foods and to constitute an important health hazard *(6)*. Their occurrence in egg products has been described by various workers *(3, 4, 5, 15, 16, 17)*, who have generally reported low counts. For example, Gibbons and Moore *(5)* reported a maximum count of 54 organisms per gram for dried whole egg solids manufactured in Canada, whereas Byrne and Rayman *(3)* reported that liquid egg prior to drying might contain 1,000 to 30,000 per gram of solids. Pasteurization reduced the count to zero by the tests used, but some samples of pasteurized egg after drying had counts of 1 to 5 per gram.

The presence of this human pathogen in egg products has led to many studies of means for eliminating *Salmonella* therefrom, especially by pasteurization *(19)*, and see also the studies cited by Osborne *et al. (10)* as follows: *4, 5, 9, 10, 11, 25, 27, 30,* and *31*. However, effectiveness of pasteurization by heat is limited because egg products are too heat sensitive to be heated enough to ensure the complete destruction of large numbers of *Salmonella* without exhibiting changes in functional properties. Whole egg and yolk, which are less sensitive to heat than egg white, nevertheless frequently receive a pasteurizing treatment of 2 minutes or more near 140° F. Liquid egg white, however, because of its great heat sensitivity, is not known to be pasteurized in commercial operations even though some studies have been made of this possibility [*27* and *29* in Osborne *et al. (10)*]. The "dry" heat treatment of egg white solids to reduce *Salmonella* counts *(1)* is now used to some extent. Lack of completely satisfactory means for destroying *Salmonella* in egg products by heat methods adds impetus to the search for alternate destruction methods such as the "cold" high energy radiation method.

Research has been carried out for several years to determine the efficacy of using high-voltage cathode rays produced by a Van de Graaff electrostatic generator for the pasteurization and sterilization of food products. Previous research at the Massachusetts Institute of Technology *(13)* has indicated that doses from 125,000 to 300,000 rep[d] were required to destroy approximately 10^6 *Salmonella* per gram in liquid whole egg in the case of certain strains of *Salmonella*. At this level of irradiation (300,000 rep), flavor changes were noted in scrambled eggs prepared from the irradiated material. However, spray drying of the liquid product after irradiation resulted in the elimination of any significant flavor difference. The results were therefore encouraging.

The purpose of the present study was to determine the doses of high-voltage cathode rays required to destroy *Salmonella* in liquid and frozen egg whites and in egg white solids when exposed in various atmospheres, and to determine the effect of high-voltage cathode rays on the flavor and functional qualities of egg white products.

MATERIALS AND METHODS

Preparation of egg products. Egg solids and the frozen egg white used in this investigation were obtained from commercial manufacturers. The unsugared and the sugared (sucrose) egg white were commercially spray-dried products from which glucose had been removed by the enzyme process. The unsugared egg white contained 5.7% of moisture, and had a pH of 7.85 on reconstitution. The sugared egg white contained 45% of sucrose and 55% of egg white solids. It had a moisture content of 2.5% and a pH of 7.50 on reconstitution. The frozen egg white was a standard commercial product. The fresh egg white was separated from fresh shell eggs of Grade A quality, procured locally.

Preparation of inoculum. *S. typhimurium* (ATCC 9187) and heat resistant *S. senftenberg* (ATCC 775W) were used in experiments to determine the cathode ray irradiation levels necessary to destroy *Salmonella* organisms in egg products. Difco bismuth-sulfite agar medium was streaked with 48-hour broth cultures of the organisms. After incubation at 37° C. for 48 to 72 hours, the culture from each plate was scraped off and suspended in 25 ml. of sterile distilled water. Suspension of the organisms was accomplished by shaking the mixture in a bottle containing glass beads. These suspensions were used to inoculate the egg products that were to be irradiated with high-voltage cathode rays. After a plate count of the inoculum was made, the inoculum was stored at 36° to 40° F. until used.

Preparation of sample containing Salmonella organisms for irradiation. A portion of the inoculum prepared as above was added to the egg solids, and the mixture was blended in a mixer to ensure an even distribution of the organisms throughout the product.

The inoculum was added in such quantity that the concentration of *Salmonella* organisms was brought within the range of 5×10^6 to 5×10^6 organisms per gram.

Two-gram portions of inoculated egg solids were weighed into 305 x 007 aluminum cans. Each can (without the top) was wrapped with porous paper, and the paper was folded together under the bottom of the can, then fastened with Scotch tape in such a manner as to cover the open top of the can. The can was then covered with an aluminum cover and sealed in an atmosphere of air, oxygen, or nitrogen. The porous paper prevented the inoculated solids from being pulled out of the can during evacuation of the system and allowed diffusion of gas into the can before sealing.

[a] Presented at the Fifteenth Annual Meeting of Institute of Food Technologists, Columbus, Ohio, June 14, 1955.

[b] Contribution No. 258, Department of Food Technology. Massachusetts Institute of Technology, Cambridge, Mass.

[c] A report of work done under a contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract is being supervised by the Western Utilization Research Branch of the Agricultural Research Service.

[d] In this paper the term *rep* is considered to represent the equivalent of 83 ergs per gram of absorbent.

The can was evacuated 3 times, filled with gas 3 times, and sealed. The pressure in the can after it was sealed was approximately atmospheric.

About the same bacterial destruction was obtained by irradiating samples in these cans as when they were irradiated in 50-ml. beakers covered with cellophane. Penetration of the aluminum cans was therefore adequate.

The inoculum was mixed with reconstituted egg white in a blender, that was run at low speed to reduce foaming. Reconstituted egg white was used rather than fresh egg white for convenience and because it more nearly represented the immediate pre-drying condition of egg white solids than fresh egg white. For treatment with high voltage cathode rays, 2-ml. portions were pipetted into a number of 305 x 007 aluminum cans, after which the cans were sealed as described previously, in an atmosphere of air, oxygen, or nitrogen. With these samples, a piece of cellophane was placed below the porous paper to prevent the liquid from being absorbed by the porous paper.

The frozen egg white was thawed and then inoculated in the manner described for reconstituted egg white. After the cans were filled and sealed, the inoculated frozen egg white was refrozen at —20° F.

Preparation of egg white solids of high-moisture content. Egg white solids of high moisture content were prepared by adding sufficient water to the dried material to bring it to the desired moisture level. The water was added while the solids were being mixed in a Hobart mixer (3-A) turning at speed No. 2 (low speed) and was added slowly to avoid large lumps. The moistened egg-white solids were transferred to an Osterizer mixer, where they were thoroughly mixed for 3 minutes. The solids were then placed in a glass jar and shaken. About 100 g. of solids could be prepared at a time by this method.

Irradiation technique. The source of the cathode rays was a Van de Graaff accelerator with a 3 m.e.v. capacity. Samples of inoculated egg products in aluminum cans were placed on a motor-driven belt, the path of which was traversed by the electron beam. In the latter part of the research, cans containing the samples were irradiated upside down to eliminate any possibility of the can rim interfering with penetration of the cathode rays. The cans containing the inoculated frozen egg white were placed in a tray of dry ice during irradiation treatment. In this manner it was possible to hold the product in the frozen state during treatment with high-voltage cathode rays.

Samples used in the functional tests (uninoculated solids) were placed in either sardine cans or polyethylene bags for irradiation treatment.

Dosimetry. Ferrous dosimetry was used to measure the irradiation doses. The procedure was that described by Proctor and Goldblith *(12)*.

Culturing irradiated samples. Following irradiation treatment, the aluminum cans containing the samples were opened with a beer can opener, which had been dipped in alcohol and flamed before use. Approximately 10 ml. of Difco selenite broth was added to each sample. The openings in the cans were then sealed with Scotch tape, and the cans were wrapped in aluminum foil. These samples were incubated for 48 to 120 hours at 37° C., after which cultures were streaked on bismuth sulfite agar. Streaked cultures were incubated for 48 hours at 37° C. and then inspected for growth of typical colonies. The results were confirmed by agglutination tests. *Salmonella* polyvalent anti-serum was used for the agglutination tests.

After irradiation, frozen egg white and reconstituted egg white were cultured in the same manner as the dried egg white except that they were incubated for 48 to 120 hours at 37° C. before the selenite broth was added. It had been found previously that this increased the number of survivors in reconstituted egg white.

Plate count method for determining Salmonella. Egg products previously sterilized by exposure to a dose of 3×10^6 rep in a Van de Graaff generator were inoculated with *Salmonella* to give test materials with counts in excess of one million organisms per gram. Samples of the inoculated test material were irradiated at different dose levels. Various dilutions of the irradiated material were made and cultured on nutrient agar at 37° C. for 48 hours. Counts were then made to determine the number of organisms surviving the irradiation. To obtain a standard degree of accuracy in these plate counts ("standard plate counts"), only those cultures showing between 30 and 300 colonies were considered.

Determination of sterilizing dose for uninoculated egg white. Two methods were used for determining the sterilizing dose for uninoculated egg solids. In the first of these methods, pieces of Tygon tubing, 2 inches long, were each sealed at one end with half a gelatin capsule. A 2-g. portion of egg solids was weighed into each tube and the top sealed with the other half of the gelatin capsule. Each filled capsule was placed in a culture tube, and the tubes were plugged with cotton and irradiated.

The second method used for egg solids involved the use of a soluble packaging film as a carrier of the sample during irradiation. Polyvinyl alcohol packaging film (Reynolon 4801) can be heat-sealed at relatively low temperatures, by first moistening the edges to be sealed. By this means, small bags of this film were made, of a sufficient size to hold just 2 g. of the product to be tested. The 2-g. sample was added to the small bag, and the open end was heat-sealed. Each plastic bag containing a 2-g. sample was inserted into a small cellophane bag, which was heat-sealed to form a closed package. These small cellophane bags were then placed in a slightly larger cellophane bag, which was also heat-sealed.

Liquid samples (frozen egg white and reconstituted egg white) were added in 2-g. portions to aluminum containers. These containers were prepared by cutting aluminum foil into sheets (5.4 cm. x 4.3 cm.) and folding the foil around a wooden block (3.0 cm. x 1.2 cm.) to form a shallow, panlike container. Each filled container was inserted in a small cellophane bag and heat-sealed to form a closed package. These small cellophane bags were then placed in a slightly larger cellophane bag, which was also heat-sealed.

After irradiation, the capsules, the shallow containers, or polyvinyl alcohol bags were transferred aseptically to large culture tubes, each containing 25 ml. of sterile thioglycollate broth. All cultures were incubated for 14 days at 37° C., after which transfers were made from each large culture tube to a small tube of sterile thioglycollate broth. The cultures in the small tubes were incubated for 2 to 7 days at 38° C. Those tubes showing growth after incubation were recorded as positive.

Viscosity. Sugared egg white solids in 6.75-g. portions and also unsugared egg white solids in 3.70-g. portions were mechanically shaken separately for one hour with 25 ml. of water. The suspension was filtered through S & S filter paper No. 589, and 6.0 ml. was introduced into an Ostwald pipette. Prior to the determinations, the pipette containing the egg suspension was placed in a water bath at 80° F. for 15 minutes. This allowed the egg suspension to come to equilibrium with the water bath before the tests were made. The viscosity measurements were made according to the standard procedure.

Viscosity measurements on approximately 200-g. amounts of reconstituted egg white solids that had been irradiated at 850,000 rep, and on unirradiated controls, were made with a Brookfield viscosimeter by measuring the drag of a spindle immersed in the reconstituted egg white.

Fluorescence. The procedure for the determination of fluorescence of egg white solids was adapted from Pearce, Thistle, and Reid *(11)*.

Ovomucin. Ovomucin was determined according to the method of Balls and Hoover *(2)*, except that all shaking was done on a mechanical shaker.

Whipping tests. A modification of the technique of MacDonnell *et al. (7)* was used in conducting drip tests. Sixty grams of previously reconstituted egg white solids, fresh egg white, or thawed frozen egg white, was added to the bowl of a Hobart mixer, Model 3-A, in a specially constructed room where the temperature was maintained at 80° F. The egg product tested was previously equilibrated to this temperature. The egg white was mixed to a stable foam at speed No. 10 (710 r.p.m.) for varying lengths of time.

After the egg white had been whipped, the mixer bowl was covered with a piece of aluminum foil. This foil had a hole in

it to allow the drip to leave the bowl when the bowl was tipped on its side. The bowl was placed on its side in a ring stand, so that the top edge was supported by a ring and the bottom by the rod of the ring stand. Some care was necessary to get the bowl in position. Below the bowl, a funnel and a graduated cylinder were arranged to catch the drip.

Readings of the amount of the drip were taken at various times, to establish a relationship between the amount of drip and the time. These results were plotted, and from the graph thus prepared, the time required to produce 9 ml. of drip was read. A quantity of 9 ml. was collected instead of the usual 0.9 ml. due to the fact that when very unstable foams were examined, the short time required to collect 0.9 ml. interfered with the accuracy of the test.

Cake volume. Angel food cakes were used in these experiments. They were made with samples of unirradiated and irradiated egg white solids, sugared egg white solids, fresh egg white, and frozen egg white. The egg white solids were reconstituted by mixing 50 g. of this product with 292 ml. of water, placing the mixture in a refrigerator for 12 hours, and then blending it with 98 ml. of water in a Waring blender at low speed (potential difference regulated at 60 volts with a Variac). During blending, the base of a flask was placed in the top layer of the liquid to prevent foaming. A similar procedure was used for reconstituting sugared egg white solids, except that 91 g. of sugared egg white solids were used initially and the baking formula was adjusted to compensate for the amount of sugar added in using the egg white.

The procedure outlined by MacDonnell *et al. (7)* was used for baking, except that the amounts of the ingredients were doubled to allow duplicate cakes to be prepared for each whipping time. Whipping times were varied, to obtain data for plotting curves of cake volume vs. whipping time. The volumes of the duplicate cakes were determined by the rape seed displacement method.

A Hobart mixer (Model 3-A) and all-purpose flour were used at first in the preparation of the cakes. These cake volumes were lower than were obtained with the Hobart mixer Model K-4-B and cake flour, but the relative differences between cakes prepared from irradiated and unirradiated material was the same. Only data obtained by the procedure of MacDonnell *et al.* are reported in this paper.

Organoleptic tests. The angel food cakes were subjected to a triangle-type test and also rated for acceptability according to scores assigned numbers from 1 *(dislike extremely)* to 9 *(like extremely)*. Approximately 20 judges participated in each organoleptic test. In this test, each judge was given 3 samples, 2 of which were the same and one of which was different and was asked to identify the like samples and to assign a flavor score to the items after segregation. The results of both the identification and the rating tests were subjected to statistical analysis by the "t" method of ascertaining significance. No order of tasting was specified to the judges and no more than two sets of samples were tested at one sitting. When calculating the hedonic numerical rating of each sample and its significance, only the scores of those judges who correctly segregated the samples or who assigned the same score to all samples were used.

Over-all evaluation of irradiated egg white solids. A sample of egg white solids was irradiated at 850,000 rep and sent to Henningsen & Co., St. Louis, Mo., for an over-all evaluation of the effect of irradiation on cake-making properties. The test sample was used in the preparation of full-size angel food cakes using commercial cake mixes to supply the ingredients other than egg white solids. The height, volume, flavor, and texture of the resultant cakes were measured and compared with results obtained with unirradiated egg white solids.

RESULTS AND DISCUSSION

Cathode ray lability of two Salmonella species. Specific inactivation doses, D_e values (dose required to destroy 62.5% of the organisms), were obtained in two ways: (a) by determining D_e from ordinary survival curves usually covering the range of 50% to 1% survival and (b) by determining D_e from the number of 2-g. samples out of 5 showing growth at various dose levels, estimated by the method of Schmidt *(13)*. In method (b), where none of the 5 samples shows growth the most probable number of survivors is less than 0.1 per gram. Since initial counts ranged from 0.3 to 10×10^8, the latter determination is based on the survival of only about 0.00001% of the initial inoculum and thus amounts to about a 10^7-fold reduction in numbers. D_e values determined in this way were generally based on irradiation at 4 or more dosage levels. It is of considerable interest that the specific inactivation doses determined in the two ways agreed within 40% of the mean of the two values (Table 1).

There is a tendency for D_e values estimated from the 10^7-fold destruction data to be smaller than the D_e values obtained from survival curves in the 50 to 99% destruction range. If it is assumed that the last organisms killed are the more resistant forms, as is generally done, we would expect high D_e values to be

TABLE 1

Comparison of D_e values determined by two experimental procedures and of dose required to reduce Salmonella count approximately 10^7-fold determined experimentally and by calculation from survival curve D_e values

Organism	Atmosphere	Specific inactivation dose, D_e		Initial *Salmonella* count	Dose required to reduce count to approx. 1 per 10 g.	
		From 10^7-fold reduction test	From survival curve		Calculated from survival D_e	Directly determined values[1]
		Thousand reps	Thousand reps	Millions per g.	Thousand reps	Thousand reps
Unsugared Egg White Solids						
S. typhim.	Air	48 ± 7	43 ± 9	1.1-3.0	700-740	780-830
	Nitrogen	38	44 ± 1	2.0-9.5	770	670
	Oxygen	43 ± 5	49 ± 5	2.0	820	720
S. senft.	Air	35	55 ± 9	0.58	860	540
	Nitrogen	37	42 ± 25	0.58	660	580
	Oxygen	31	40 ± 3	4.8	700	560
Sugared Egg White Solids						
S. typhim.	Air	39	85 ± 21	2.7	1,400	670
	Nitrogen	44 ± 1	66 ± 10	1.0-9.7	1,100-1,200	720-820
	Oxygen	37	75 ± 8	2.7	1,300	640
S. senft.	Air	51	61 ± 1	1.0	980	820
	Nitrogen	60 ± 1	50 ± 6	1.4	820	990
	Oxygen	56	55 ± 1	1.0	890	910
Reconstituted (liquid) Egg White						
S. typhim.	Air	19 ± 6	25 ± 3	1.4 -4.0	410-440	310-330
	Nitrogen	20 ± 6	19 ± 3	0.28-14	290-370	300-380
	Oxygen	14 ± 6	20 ± 4	0.28-25	300-390	210-270
S. senft.	Air	14 ± 6	16 ± 5	1.7-42	260-310	230-280
	Nitrogen	15 ± 6	14 ± 3	1.7-42	230-270	250-300
	Oxygen	9 ± 2	18 ± 1	1.7-42	290-330	150-180
Frozen Egg White						
S. typhim.	Air	16 ± 6	13 ± 4	0.21-15	190-250	230-300
	Nitrogen	21 ± 4	13 ± 3	1.1 -5.3	210-230	350-380
	Oxygen	19 ± 1	12 ± 3	1.1 -5.3	190-210	310-340
S. senft.	Air	8 ± 1	12 ± 1	0.26-0.73	180-190	120-130
	Nitrogen	10 ± 3	8 ± 1	0.26-2.0	110-120	150-170
	Oxygen	7 ± 1	9 ± 1	0.26-0.73	130-140	100-110

[1] These values were calculated from the number of tubes out of five (each containing 2 g.) showing growth at various dose levels by the method of Schmidt *(13)*. The values for D_e in column three are essentially extrapolated values from these data. The values in columns six and seven are influenced by the initial count.

obtained from the 10^7-fold destruction data. Since it tends to be lower, if anything, and since the difference is not great, the observations make it appear that the target theory expression, $n/n_o = e^{-D/D_o}$, is a good representation of the irradiation destruction of *Salmonella* over a 10^7-fold destruction range. In this expression n_o is the initial number of microorganisms, n is the number surviving dose D, and D_o is the specific inactivation dose.

Expressed in another way, the data in Table 1 show that the directly determined doses required to destroy approximately 10^7 *Salmonella* per gram corresponding to 0.00001% survival (column 7) do not exceed significantly the values calculated from the data obtained at the 1% (or greater) survival level (column 6). Only in the case of *S. typhimurium* in frozen egg white was the average dose requirement greater when determined from the 0.00001% survival data (Table 2).

TABLE 2
Comparison of average destruction doses obtained for four types of egg and two Salmonella species [1]

Type of egg white	*Salmonella* species	Destruction dose			
		10^7-fold kill		10^{11}-fold kill [3]	
		from 10^7-fold kill data [2]	from survival curve	from 10^7-fold kill data	from survival curve
		thousand reps	*thousand reps*	*thousand reps*	*thousand reps*
Reconstituted (liquid)	typhim.	285	340	450	540
Reconstituted (liquid)	senft.	205	260	320	410
Frozen	typhim.	300	210	475	310
Frozen	senft.	135	160	210	250
Solids (dry)					
Unsugared	both	680	730	1070	1150
Sugared	both	925	1100	1450	1740

[1] The values reported in each case are averages of data obtained in air, nitrogen and oxygen, since these treatments did not influence the dose requirements under the conditions used in this study.

[2] These values are for practical purposes observed values, since they were obtained by the method of Schmidt *(13)* from actual kills of this order of magnitude corrected only for the relatively minor differences in initial counts.

[3] These are extrapolated values.

It was found that essentially the same *Salmonella* destruction doses were required for irradiations in air, nitrogen, and oxygen for all 4 forms of egg white (Table 1). In comparing the effect of other treatments it is therefore justified and helpful to consider the runs in the various atmospheres as simple replicates.

Marked differences were found in the *Salmonella* resistance in egg solids as compared with liquid and frozen egg. Although D_o values frequently vary considerably from run to run as indicated by the data in Table 1, it seems clear that the dose required to kill *Salmonella* organisms in dry egg white is definitely 2 to 3 times the dose required to kill them in liquid or frozen white (Table 2).

Examination of the D_o values for egg-white solids in Table 1 shows that there is no difference in dose requirement for *S. typhimurium* or *S. senftenberg*. Therefore the values for both species have been averaged in preparing Table 2. On the other hand, in liquid and frozen egg white *S. senftenberg* seems more sensitive than *S. typhimurium*. The D_o values for *S. senftenberg* in frozen and liquid egg white average about 70% of the D_o values for *S. typhimurium*. The difference in D_o values for these species is thus small compared with the difference in D_o values for dried and liquid (or frozen) egg white. In another study *(13)* it was found that *S. senftenberg* was destroyed at about 40% of the dose required to destroy a similar number of *S. typhimurium* or *S. paratyphi*.

Consideration of "practical" destruction dose evaluation. It is not the purpose of this paper to define the degree of destruction of *Salmonella* that would be acceptable from a health-hazard point of view. Obviously, complete destruction is desirable but it is scientifically accurate to speak only of a zero count (no *Salmonella*) with a certain degree of probability. Thus if the original count is 10^8 and we treat the material with a 10^7-fold destruction dose, then only about one 1-g. sample in 10 will have a viable *Salmonella*. This is equivalent to saying that the viable *Salmonella* content for 1-g. samples is zero with a 10-to-1 probability.

Since it has been demonstrated in this study that the target theory expression holds for *Salmonella* over a wide range, it is possible to consider, with some confidence, dose requirements (obtained by extrapolation) for high levels of kill. Calculation is simplified by rewriting the target theory expression in the form

$$\frac{n}{n_o} = 10^{-a} = e^{-D/D_o} \qquad (1)$$

where a equals the reduction factor desired. Thus a would be 7 for a 7-fold reduction, etc.

The equation shows that the dose D corresponding to factor a is in fact directly proportional to a, as follows:

$$D = 2.3\, D_o a \qquad (2)$$

This equation was used to obtain the values reported in Table 2 where values for both 10^7 and 10^{11}-fold destruction are given. In the latter case, if there were 100 *Salmonella* per gram initially, application of the doses indicated would reduce the numbers so that there would be less than one viable *Salmonella* per 10^9 grams or per 2.2 million pounds.

Destruction of microorganisms other than Salmonella. Limited observations showed that 2- to 5-fold higher doses were generally required to destroy the various contaminating organisms found in uninoculated egg products than were required for destruction of *Salmonella*.

Organoleptic, volume, and commercial tests on cake-making properties of egg white treated with cathode rays. Triangle difference tests indicated that angel cakes prepared with unsugared egg white solids irradiated at a dose level of 850,000 rep are not significantly different from cakes prepared from unirradiated solids of the same type (Table 3). However, at a cathode-ray dose level of 1,000,000 rep, a difference significant at the 5% level was found.

Cakes made from sugared egg white solids that were irradiated with a dose of 850,000 rep were compared organoleptically with cakes prepared with unirradiated sugared egg white solids. The taste panel was able to

distinguish between the two samples (5% level, triangle test), but the hedonic scale difference was not significant.

Seven triangle tests were made on cakes prepared from fresh egg white irradiated at 450,000 rep. In 4 tests the difference between irradiated and control samples was not significant. In one test it was significant at the 5% level, and in 2 tests it was significant at the 0.01% level. The significant difference at the 0.01% level may have been due to variations in the preparation of samples for testing and to the fact that separate lots of fresh egg white were used in each test.

Frozen egg white irradiated at 500,000 rep was not significantly different in flavor from the control when tested in angel cakes. In general, the use of egg white products irradiated at dose levels above 1,000,000 rep resulted in angel cakes having significant organoleptic differences. In these cases the controls were preferred to the irradiated cakes. It may be noted also that 22 out of the 28 acceptability scores reported in Table 3 are lower for the irradiated sample than for the control.

The volumes of angel cakes prepared from irradiated egg white products tend to be slightly less than those of cakes made from unirradiated material. In the case of fresh egg white irradiated at 850,000 rep, there was little, if any, difference between the volumes of cakes prepared from irradiated and unirradiated material (Table 4). The volume of angel cakes prepared from frozen egg white irradiated at 500,000 rep was not significantly lower than the volumes of angel cakes prepared from unirradiated frozen egg white but it appeared to take a somewhat longer whipping time to reach the maximum cake volume in the case of irradiated material (Figure 1). Irradiation of frozen egg white at 1,000,000 rep resulted in a significant but small (<10%) lowering of the maximum volume of prepared angel cakes even at extended whipping times.

Cakes prepared by the laboratory procedure from unsugared and sugared egg white solids irradiated at 850,000 rep also had somewhat less volume than cakes prepared from the unirradiated product. These differences, while real, are not important as indicated by the following test.

TABLE 3

Acceptability scores for angel food cakes baked with irradiated and unirradiated egg white products

Sample and irradiation dose (rep)	Acceptability scores[1]			Number of judgments		
	Control	Irrad.	Sig. level	Correct	Incorrect	Sig. level
Unsugared egg white solids (low moisture)						
0.85 x 10^6	6.6	5.8	.....[4]	11	10	Not
0.85 x 10^6	6.4	6.7	.....	7	15	Not
1.0 x 10^6	5.4	4.0	.....	12	8	5%
4.0 x 10^6	6.0	4.8	.....	11	9	5%
Sugared egg white solids (low moisture)						
0.85 x 10^6	5.8	5.2	.....	12	8	5%
0.85 x 10^6	6.2	5.8	.....	12	8	5%
1.5 x 10^6	5.8	3.3	.....	12	8	5%
4.0 x 10^6	6.6	5.1	.....	12	8	5%
Sugared egg white solids (high moisture)						
1.0 x 10^6	5.6	5.2	.....	13	7	1%
4.0 x 10^6	4.4	3.6	.....	14	6	0.1%
Fresh egg white						
0.45 x 10^6	6.4	6.7	.....	7	15	Not
0.45 x 10^6	5.9	5.8	.....	11	10	Not
0.45 x 10^6	6.4	5.7	.....	16	4	0.01%[2]
0.45 x 10^6	7.5	6.3	.....	16	4	0.01%[2]
0.45 x 10^6	7.0	6.0	5%	6	14	Not
0.45 x 10^6	6.4	6.6	Not	13	8	5%
0.45 x 10^6	6.9	7.3	Not	10	10	Not
2.0 x 10^6	5.8	5.7	.....	9	11	Not
3.0 x 10^6	6.5	4.9	.....	14	6	0.1%
3.0 x 10^6	6.1	5.5	.....	14	6	0.1%
3.0 x 10^6	7.5	6.0	.....	13	7	1%
Frozen egg white						
0.50 x 10^6	6.2	5.5	.....	5	15	Not
0.50 x 10^6	6.0	6.9	Not	9	11	Not
0.50 x 10^6	6.6	7.1	Not	8	12	Not
1.0 x 10^6	7.1	6.3	.....	16	4	0.01%[2]
1.0 x 10^6	7.5	6.4	Not	7	13	Not
1.0 x 10^6	6.1	5.4	Not	9	11	Not
2.0 x 10^6	6.7	5.5	Not	8	12	Not
2.0 x 10^6	7.4	5.9	5%	10	10	Not
3.0 x 10^6	7.2	5.1	0.1%	14	6	0.1%

[1] The taste panel rated the samples for acceptability according to the following scores:
Score No. 1—*Dislike extremely*
Score No. 2—*Dislike very much*
Score No. 3—*Dislike moderately*
Score No. 4—*Dislike slightly*
Score No. 5—*Neither like nor dislike*
Score No. 6—*Like slightly*
Score No. 7—*Like moderately*
Score No. 8—*Like very much*
Score No. 9—*Like extremely*

[2] See discussion in text.

[3] The reason for this atypical result is not evident. It is very questionable whether the difference reflects the irradiation treatment, however.

[4] ..... indicates that the significance level was not calculated.

TABLE 4

Effect of high-voltage cathode rays (850,000 rep) on volume of angel cakes made with fresh egg white

Whipping time (sec.)	Cake volume, cc.	
	Unirradiated	Irradiated
20	551	526
50	541	554
75	568	554

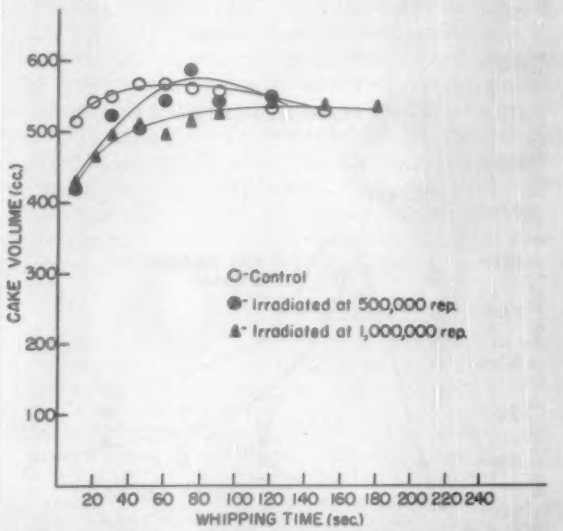

Figure 1. Effects of cathode ray irradiation and whipping time on volume of angel cakes made with frozen egg white.

Evaluation of irradiated (850,000 rep) egg white solids was carried out in a commercial laboratory (Table 5). No flavor deficiencies were noted in the prepared cakes. The texture scores are based on a 14-point scale in which cell structure, especially size, and cell-wall strength and thickness are important. A score of 7 to 8 is considered very satisfactory. The irradiated egg-white solids sample tested gave texture scores of 7 or better in all cases. A report from the commercial laboratory stated that "results on our regular product (from which the irradiated material was drawn) fall right in line with these data. In our opinion these results indicate that little, if any, damage resulted from the irradiation." It is evident that no serious functional property changes are caused by irradiating egg white in various forms at doses up to one million rep. The changes that occur in both flavor and cake-making properties were not significant in the practical test conducted.

TABLE 5

Effect of cathode ray irradiation (850,000 rep) on over-all properties of angel cakes prepared from irradiated egg white solids (commercial laboratory results)

Cake mix manufacturer	Beating time	Specific gravity	Height In (mm.)	Height Out (mm.)	Volume (ml.)	Flavor	Texture[1]
B	3' 10"	0.150	128	118	5080	Satis.	7
B	3' 17"	0.150	128	117	4940	Satis.	7
C	3' 45"	0.150	135	121	5100	Satis.	8
C	3' 45"	0.150	135	120	5050	Satis.	9
D	3' 10"	0.150	113	99	3980	Satis.	9
D	3' 04"	0.150	112	100	4110	Satis.	9
E	3' 20"	0.150	126	115	4710	Satis.	8
E	3' 27"	0.150	126	113	4730	Satis.	7+
F	4' 10"	0.150	137	124	5110	Satis.	7

[1] Based on 14-point scale.

The foam stability of the unirradiated fresh and frozen egg white differed, as is frequently the case for different samples of egg white. Optimum stability occurred at about 60 seconds of whipping for fresh egg white and at about 30 seconds for the frozen. In both cases, irradiation at 450,000 to 500,000 rep caused marked differences in foam stability from the control at short whip times (Figure 2). However, both irradi-

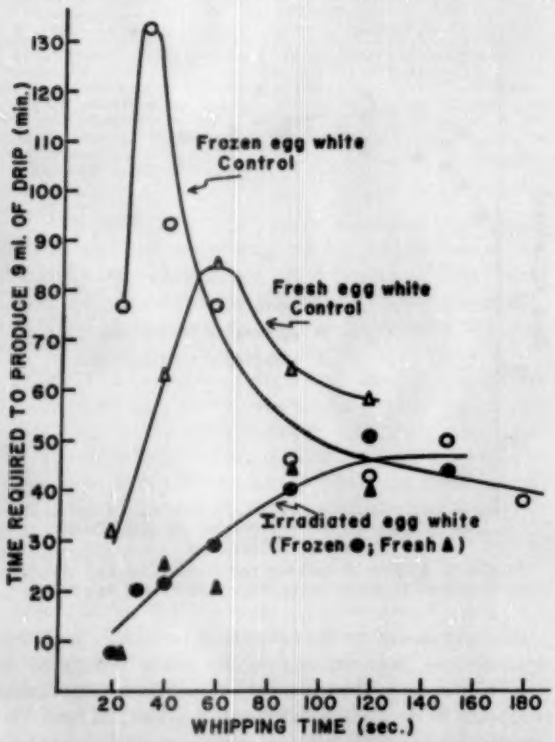
TIME REQUIRED TO PRODUCE 9 ml. OF DRIP (min.)
WHIPPING TIME (sec.)
Frozen egg white Control
Fresh egg white Control
Irradiated egg white (Frozen ●; Fresh ▲)

Figure 2. Effect of cathode ray irradiation and whipping time on foam stability of fresh and frozen egg white.

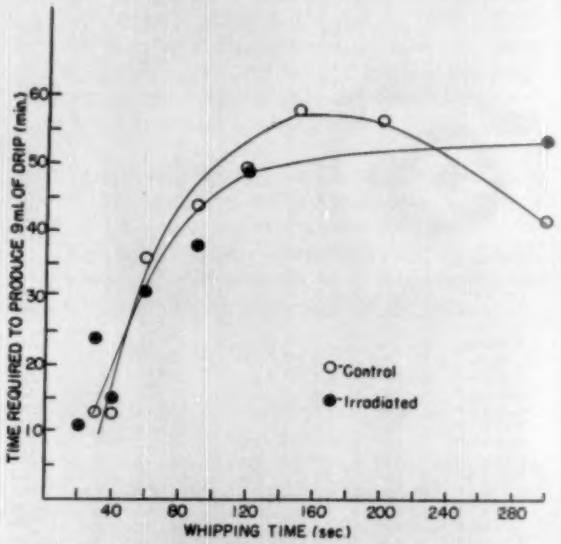

Figure 3. Effects of cathode ray irradiation and whipping time on foam stability of unsugared egg white solids.

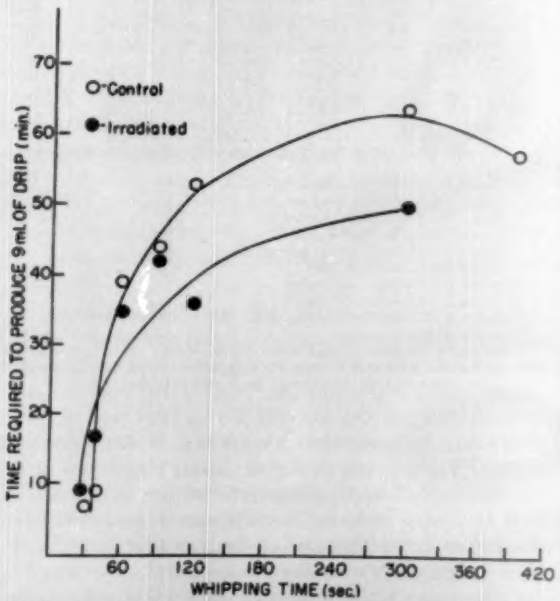

Figure 4. Effects of cathode ray irradiation and whipping time on foam stability of sugared egg white solids.

ated samples had essentially equal stability characteristics. Maximum stability for the irradiated samples occurred at a whip time of about 100 seconds and was only half to a third of the maximum stability exhibited by the control samples.

There was little difference between the stability characteristics of the foam of irradiated and unirradiated unsugared egg white solids (Figure 3). With sugared egg white solids, the irradiated product possibly had somewhat less foam stability than the unirradiated control at the longer whip times (Figure 4). In the case of both the irradiated and the unirradiated sugared egg white solids, maximum stability appeared to be reached at about 300 seconds whip time.

There were no significant differences in solubilities, viscosities, and ovomucin contents of the unirradiated and irradiated egg white solids (Table 6). The viscosity of the high-moisture sugared egg white appeared

TABLE 6
Effect of high-voltage cathode rays on properties of dried egg white powders

Sample and treatment	Percent solubility	Viscosity[1]	Fluorescence (% T)	Ovomucin (%)
Unsugared (low moisture)				
Control	91.7	175	27.7	2.19
Irradiated at 1.0 x 10^6 rep	88.6	-----	34.3	2.37
Irradiated at 2.0 x 10^6 rep	-----	179	-----	-----
Sugared (low moisture)				
Control	88.7	215	31.1	1.66
Irradiated at 1.0 x 10^6 rep	89.0	-----	39.4	1.78
Irradiated at 2.0 x 10^6 rep	-----	215	-----	-----
Sugared (high moisture)				
Control	-----	187	17.5	1.83
Irradiated at 1.0 x 10^6 rep	-----	-----	20.1	1.78
Irradiated at 4.0 x 10^6 rep	-----	191	-----	-----

[1] Expressed as number of seconds for egg suspension to traverse distance between etched marks on Ostwald pipette.

to be lower than that of the low-moistured sugared egg-white solids. However, irradiation had no effect on viscosity in either case. McArdle and Desrosier *(8)* found that irradiation of 2% albumen solutions resulted in significant increases in viscosity. The difference between the results obtained here and those of McArdle and Desrosier reflects a difference in the effect of irradiation in the dry state and in aqueous solution.

SUMMARY AND CONCLUSIONS

Salmonella was more resistant to irradiation in dried egg white products than in liquid or frozen egg white. The average dose of high-voltage cathode rays (3 m.e.v.) required to cause a 10^7-fold destruction of *S. typhimurium* and *S. senftenberg* in unsugared egg white solids was found to be about 700,000 rep, and in sugared egg white solids about 1,000,000 rep. With reconstituted (liquid) egg white, the 10^7-fold destruction dose was about 300,000 rep for *S. typhimurium* and about 230,000 for *S. senftenberg*. With frozen egg white, the dose for *S. typhimurium* was about 260,000 rep and for *S. senftenberg* about 150,000. Dose values obtained on individual runs generally did not differ more than 20% from these average values. Atmospheres of air, oxygen, and nitrogen had little or no effect on the resistance of these organisms to irradiation. It would appear to require only about a 50% increase in the 10^7-fold reduction dose to obtain 10^{11}-fold reduction, which may be considered a reduction factor comparable with that used in the canned food industry.

Flavor tests on angel cakes prepared with unirradiated and irradiated egg white showed, in general, no significant difference. In the case of sugared egg white solids, there was a flavor difference significant at the 5% level.

The volume of angel cake prepared from irradiated egg products exhibited either the same or a slight decrease in volume compared with the control. In some cases it took a longer whip time to reach the maximum foam volume. Thus "pasteurizing" doses of irradiation cause only limited changes in the useful properties of egg white. This was confirmed by independent tests conducted in a commercial laboratory on full-sized angel cakes. The flavor, volume, and texture of angel food cakes prepared from egg white solids irradiated at 850,000 rep did not differ from cakes prepared with unirradiated commercial egg white.

The stability of foam prepared from irradiated fresh and frozen egg white was markedly decreased compared with foams from unirradiated control. Irradiation of sugared and unsugared egg white solids, however, had very little effect on foam stability.

The solubility, viscosity, and ovomucin content of sugared and unsugared egg solids did not change significantly on irradiation. The fluorescence of both sugared and unsugared egg-white powder increased slightly on irradiation.

It appears therefore that an irradiation dose causing a 10^7-fold reduction in *Salmonella* organisms in egg white products causes only minor deteriorations in the functional and organoleptic properties of these products. The most noticeable change occurred in the foam stability of fresh and frozen egg white. Distinct but minor changes occurred in the foam stability of sugared and unsugared egg white solids, the organoleptic properties of unsugared egg white solids, fresh egg white, and frozen egg white and cake volumes of angel cakes prepared from both sugared and unsugared egg white solids (as determined by small-scale tests).

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Development and Evaluation of New Wheat Varieties[a, b]

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(Manuscript received June 23, 1956)

Wheat variety research is always fluid because of plant disease changes, agronomic practices, etc. Changes in the prevalent races of stem rust are outstanding examples of how disease affects wheat variety work. To prevent wholesale destruction of the wheat crop immediate steps must often be taken to develop wheats resistant to the threatening race. These wheats must be acceptable in quality, of course, as well as rust resistant.

The general procedure for developing a rust resistant variety can be quickly stated. To start with, parental material must be available which is resistant to the rust race. This is crossed with a wheat of satisfactory agronomic characteristics and milling and baking quality. Each cross made results in only one seed which contains all the genes of the two parents, the number of which are not known. In the next generation each seed or kernel differs from the others and may possess any possible combination of the characteristics of the original parents. The likelihood of obtaining all of the desired properties in one seed is therefore very improbable.

Although it may normally require from 12 to 15 generations to obtain sufficient seed for release for commercial production, the time needed has been markedly reduced in recent years by the use of greenhouse space for two crops each year in the early generations. This procedure in the spring wheat area yields a total of three crops per year. As soon as sufficient seed is obtained it is sent to California or Arizona or even Mexico for winter increase under irrigation. Large yields per acre are possible under these conditions. In the spring the wheat is returned to North Dakota for late seeding. By these procedures it has been possible to meet emergency situations in a remarkably short time. Incidentally, this station and the U. S. Department of Agriculture recently developed and released four new durum varieties resistant to 15B stem rust and satisfactory in quality in the space of 4 to 5 years. However, so short a time is not advisable except during the onset of a serious disease, when accelerated procedures are virtually mandatory.

From the segregates obtained from the original cross, plants are selected which promise good resistance, yield, and other desirable agronomic properties. These preliminary selections are increased until a sufficient quantity has been obtained for quality testing by so-called "micro" methods. This occurs in about the sixth (or later) generation after the original cross. It is hoped that in time sufficient material will be available from the third generation, which is the earliest possible.

This paper discusses the quality evaluation of selected progeny of a Rushmore x Kenya 338AC cross which offered a comparatively wide range of quality characteristics. In addition, a brief resume is given of the methods used in the breeding of these hybrids.

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 12, 1956.
[b] Published with the approval of the Director.

WHEAT BREEDING

Figure 1 represents schematically the method by which new hybrids are produced by crossing from parental material containing qualities desired in a variety destined for growth in the spring wheat area. In the present case resistance to stem rust complex 15B was desired, and one of the parents, Kenya 338AC, was known to possess it in a marked degree. Kenya, however, has several undesirable agronomic characteristics as well as poor milling and baking quality. It was therefore necessary to cross Kenya with a variety of satisfactory quality to obtain improved milling and baking properties in the offspring combined with the desired 15B stem rust resistance. Rushmore, as outlined in Figure 1, has several parents satisfactory in quality. The names of these, with the countries where they originated, are shown. For example Marquis, once thought the acme of perfection in Western Canada, when crossed with Kota, an inferior quality wheat from Russia, produced Ceres, which was widely grown in North Dakota. By crossing Ceres with the product of a Hope-Florence cross, Rival was obtained. This variety has also been widely grown in North Dakota. Finally, a cross made at South Dakota between Rival and Thatcher produced Rushmore. It is notable that Marquis occurred three distinct times in the parentage of Rushmore. Hope, which originated from the cross Marquis x Yaroslav, is another source of Marquis parentage. It is evident that the ND (North Dakota) hybrids thus stem from wheats originating in many

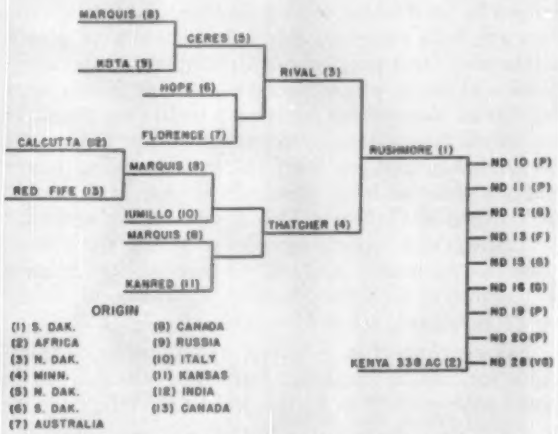

Figure 1. Schematic representation of the production of new wheats by crossing parents of known agronomic and quality characteristics using Rushmore and Kenya 338AC as examples. Numbers in parentheses refer to the origins of the wheats. General quality of the new ND hybrids is represented as follows: VG = very good; G = good; F = fair; P = poor.

regions of the world. From the cross Kenya x Rushmore a whole series of wheats of varying degrees of disease resistance and quality were produced. Some of these are represented as ND numbered progeny at the right of the figure with an indication of their general quality.

A simplified representation of the inheritance of dark vitreous kernel appearance and starchy endosperm is shown in Figure 2. By crossing a red kernel appearance and starchy endosperm, four distinct types of hybrids are produced. One of these will possess a red kernel associated with vitreous endosperm, one will have a red kernel and starchy endosperm, while two will have a white kernel, one of which will have a vitreous endosperm and the other a starchy endosperm.

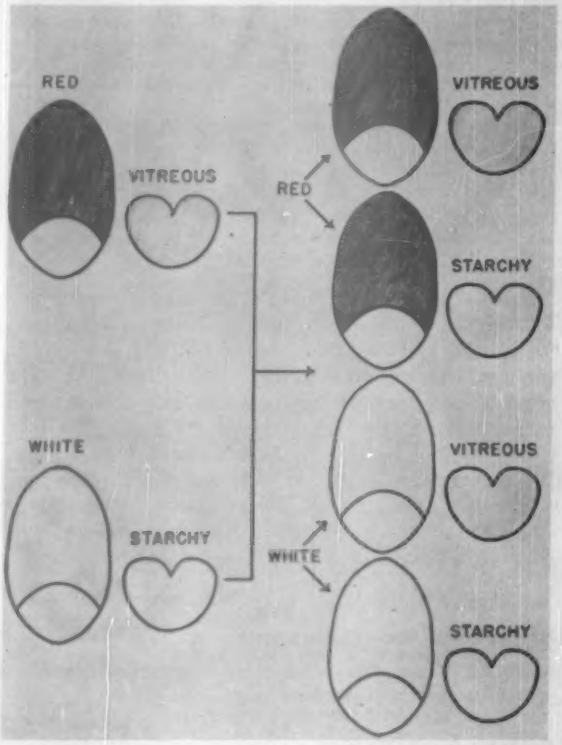

Figure 2. Illustration of recombination of kernel characters in the progeny from a cross between a red vitreous wheat (Rushmore) and a white starchy wheat (Kenya 338AC).

Also, intermediate types would be expected to occur. Whether these will breed true for future generations will depend upon the particular gene or group of genes responsible for each character. True-breeding forms of each of these classes may be derived.

MATERIALS AND METHODS

Progenies from a cross between two wheats, Rushmore and Kenya 338AC, were evaluated for milling and baking quality. These progenies had been selected from a large number of lines (about 700) for desirable agronomic characteristics and disease resistance and to some degree for satisfactory quality. They were comparably grown with the parents in nursery rod rows at Fargo in 1955.

Initial milling, baking and other quality tests were made on approximately 200 g. of wheat. The sample was cleaned on appropriate equipment, and the test weight ascertained by a micro method described by Harris and Sibbitt *(3)*. An aliquot was ground to pass through a 100-mesh sieve and used for a protein determination. The moisture content was ascertained by passing the wheat through a Tag-Heppenstall moisture meter before grinding for the protein test.

Samples of 150 g. of the thoroughly cleaned wheat were used for the milling. A small two-stand mill equipped with a sifter and designed especially for milling small quantities of wheat was used *(1, 6)*. A modified milling method has recently been

developed in this laboratory that permits the processing of from 20 to 25 samples per day. Tempering procedure was the same as for larger sample milling, including tempering to 13.5% moisture content the night before, and further addition of water about one-half hour before the actual milling to raise the final value to 15.0% to prevent pulverization of the bran by the break rolls.

A micro-baking method was used to determine the baking quality of the flour *(2)*. This method requires 25 g. of flour, and embodies a formula designed to bring out the latent strength of the sample. Suitable fermenting bowls and pans were used, with a small mixer. The size or volume of the loaf was obtained about one-half hour after baking and the crumb characteristics were judged the following morning.

The physical changes which took place while mixing the dough, or the mixing requirements, were evaluated by the mixograph *(4, 5)*. This apparatus, very familiar to cereal chemists, needs 25 g. of flour for a test. The absorption used for baking was employed for this test also.

RESULTS AND DISCUSSION

Milling properties. Table 1 provides a comparison between the quality of the parental material and that of the hybrids resulting from the cross. For test weight, although Kenya was higher than Rushmore, the progeny had a greater range, and their average test weight was slightly higher than for Kenya. The protein content of Kenya was higher than for Rushmore; but the average for the hybrids was higher than that of either parent, although the minimum for Rushmore and the progeny was the same. Rushmore was better in flour yield than Kenya, while the hybrids had samples

TABLE 1
Maximum, minimum and mean protein content and milling data for Rushmore, Kenya 338AC and their progeny

	Test weight	Wheat protein[1]	Kernel appearance	Flour yield	Milling characteristics
Rushmore	*lbs./bu.*	%		%	
Max.	56.0	14.7	Red-Vitreous	75.0	Normal
Min.	55.5	14.0	Red-Vitreous	71.6	Normal
Average	55.7	14.3	Red-Vitreous	73.8	Normal
Kenya 338AC					
Max.	60.0	16.0	White-Starchy	72.1	Abnormal
Min.	55.5	14.9	White-Starchy	66.3	Abnormal
Average	57.1	15.3	White-Starchy	69.5	Abnormal
Progeny					
Max.	61.0	16.9	Red-Vitreous	77.1	Normal
Min.	54.0	14.0	White-Starchy	63.2	Abnormal
Average	57.9	15.8	White-Starchy	70.1	Abnormal

[1] Expressed on 13.5% moisture basis.

both higher and lower in flour yield than either parent, but with an average value slightly above Kenya. Kernel appearance and milling characteristics followed a similar pattern of distribution in the hybrids. Thus, the results offer a choice of quality properties among the hybrids from which desired quality factors may be selected for further testing.

Figure 3 represents the comparative flour yields of the two parent wheats and of their progeny, illustrating the proportion of the progeny which both exceeded and fell below the parents in range. The greatest frequency approached the yield of Kenya rather than the higher yield of Rushmore. About 17.5% exceeded the yield of Rushmore, while 42.5% were below both parents. There were 7.5% with a flour yield of 76.7%, approximately 3.0% above Rushmore. Thus, in selecting for flour yield, the wheat breeder would concentrate on the 17.5% above Rushmore and choose those satisfactory in yield per acre, disease resistance, and other agronomic properties. Further selections might be made from the best in the 72% flour yield class, which comprise 15% of the progeny, but there seems little justification for selecting from the lower yielding

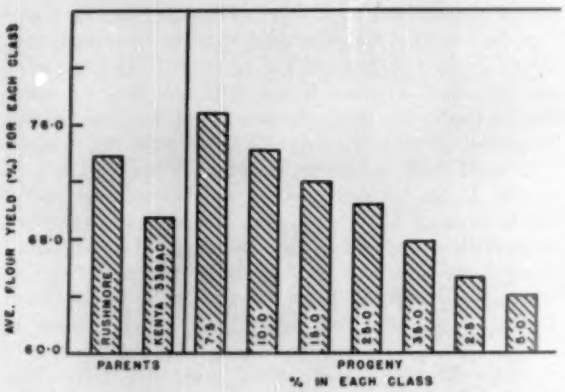

Figure 3. Comparative flour yields of Rushmore and Kenya 338AC and their progeny showing the percentage of the progeny falling into each flour yield class average.

groups which include 42.5% of the total unless the selection was satisfactory agronomically and in other quality characteristics.

Usually wheats low in flour yield tend to mill poorly, causing difficulty in reducing the middlings and sifting as judged by hard wheat milling standards. Although the data are from one year only, all samples were grown comparably, including standard samples whose agronomic and quality properties are well known from a large number of observations covering 5 to 10 crop years. If the hybrid is particularly promising, further tests might be advisable, perhaps even macro tests using larger samples obtained from experimental plots at a number of locations in the state. This is our usual practice for evaluating very promising wheats. Data from these tests can be readily analyzed to ascertain the relative importance of the effects of year, location, and variety on all agronomic and quality tests.

Baking properties. Table 2 shows similar comparisons for baking quality. Rushmore was higher in water absorption than Kenya, while the average for the

TABLE 2
Maximum, minimum and mean baking results and mixogram patterns for Rushmore, Kenya 338AC and their progeny

	Absorption	Dough characteristics	Loaf volume	Crumb color	Crust color[1]	Mixogram pattern
Rushmore	%		*cc.*			
Max.	64.0	Very good	205	7.5	S	Strong
Min.	63.2	Very good	190	6.5	S	Med. Strong
Average	63.5	Very good	198	7.0	S	Med. Strong
Kenya 338AC						
Max.	62.4	Fair	180	6.0	Sl. P.	Medium
Min.	60.0	Fair	160	6.0	Sl. P.	V. Weak
Average	60.6	Fair	171	6.0	Sl. P.	Med. Weak
Progeny						
Max.	64.8	Very good	225	8.5	S	V. Strong
Min.	58.8	Fair	165	5.5	P	Ex. Weak
Average	62.0	Good	190	6.6	S	Med. Strong

[1] S = *satisfactory;* Sl. P. = *slightly pale;* P = *pale.*

progeny was between the two parents, although the maximum and minimum values exceeded the range of the parental material. Dough characteristics at panning were very good for Rushmore, but only fair for Kenya. The hybrids varied from very good to fair, with an average rating of good. For loaf volume and crumb color Rushmore was superior to Kenya, while the progeny contained wheats some of which were better than either parent in loaf volume, but were generally both superior and inferior to the parents in crumb color. Hybrids with good field performance and in the higher bracket for quality properties would be selected for seed increase and more intensive milling and baking tests, utilizing macro-sized samples and methods *(2)* as described for flour quality.

In a similar manner Figure 4 shows a representative loaf volume distribution in comparison to that of the parents based upon the original data. About 2.5% of the progeny had an average loaf volume of 225 cc. or 27 cc. more than Rushmore, and 54 cc. above Kenya. Some 12.5% were significantly above Rushmore, and 27.5% equal to Rushmore. No class average was below Kenya although 25.0% were only 3 cc. higher in aver-

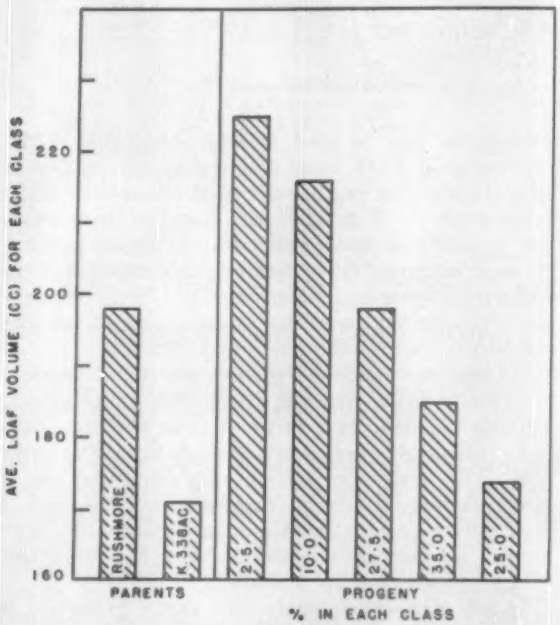

Figure 4. Comparative loaf volume of Rushmore and Kenya 338AC and their progeny showing the percentage of the progeny falling into each loaf volume class average.

age volume. It is evident that there is an excellent opportunity among the progeny to select potential new varieties superior in loaf volume to either parent, and thus develop a wheat possessing very satisfactory flour loaf volume.

Physical dough tests. Figure 5 provides information on the mixogram patterns of the parents and their progeny. As for flour yield and loaf volume there was a marked range in pattern among the hybrids. A few were much weaker than Kenya and would not be considered for further increase since it is important that

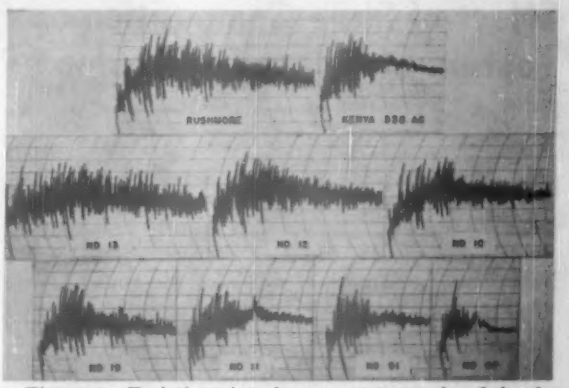

Figure 5. Variations in mixogram patterns found in the progeny from the cross Rushmore x Kenya 338AC compared with patterns of the parent wheats.

satisfactory mixing strength be maintained in hard red spring wheats. Selections could be made from hybrids of good mixing quality which are promising in other characteristics.

CONCLUSIONS AND SUMMARY

Progeny from a cross between two wheats, Rushmore and Kenya 338AC, of different milling and baking quality, varied greatly in milling, baking and physical dough properties. The range in quality characteristics generally tended to exceed that between the parent types. This suggests the possibility that two mediocre quality wheats might be crossed and yield either a good or a poor quality progeny.

From the range in properties among the hybrids it is possible to select wheats with satisfactory quality for future increase and more exhaustive testing, using larger samples and equipment. In addition the effect of different environmental conditions during growth can be analyzed.

Information on the mode of inheritance of the quality factors in wheat is badly needed to aid the wheat breeder in developing new varieties as rapidly as possible to resist threatening plant diseases.

Acknowledgment

The authors are indebted to Dr. G. S. Smith for pertinent advice and suggestions on the preparation of this report.

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Effect of Sirup Composition on Flavor and Texture of Canned Clingstone Peaches[a]

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(Manuscript received June 22, 1956)

GRANULATED AND LIQUID SUGARS of various types and composition are used widely at present in the food industries. Knowledge of the physical properties and chemical activities of sugars and sugar solutions prepared from commercially available granulated and liquid sugars that would be useful in evaluating their effect on stability and acceptability of fruits and fruit products is still limited. Investigations of the technological bases for the selection of sugars and sirups for particular fruit products have been under way in our laboratories for some time. One of the earliest reported studies of this type was that made by Shaw in 1907 comparing beet sugar with cane sugar *(12)*. Although some comparative data on the effect of sugars on frozen fruits and fruit products are available *(9)*, similar data on the effect of different sugars on canned fruits and fruit products have not been published *(2)*.

Replacement of part of the sucrose in sirups used in canning fruits by corn sirup solids is now an established practice in the canning industry, and its use is recognized in the existing standards of quality and identity. At the permitted replacement level (25%) little if any difference between the all-sucrose packs and the sucrose-corn sirup packs has been noticed or reported by the quality control staffs of canners using these packs. In 1951, however, sufficient differences in appearance, flavor and texture of canned clingstone peaches packed in sucrose-corn sirup in comparison with sucrose was observed in an experimental pack in one of the California canneries to justify further investigations.

The annual pack of canned clingstone peaches in California in recent years has averaged about 17 million cases *(18)*. Even in the 1920's when the average annual pack was half as large there was concern over the possibility of economically marketing this pack *(6)* and this is true now *(8)*. An extensive market survey was made in 1929 in which definite consumer preferences for flavor, sweetness, size, uniformity, color, freedom from blemishes, and workmanship were found *(6)*. Of these factors, the preference for sweetness was quite interesting.

It has been the tradition in the fruit canning industry to can fruit of the best quality in sirup of the highest density and this was recognized in the California Canned Fruit Standardization Act of 1925 *(5)*. This Act as amended in 1929 specified that, in addition to minimum standards of size, uniformity of size, color, and ripeness, "if at the time of packing, the liquid surrounding the fruit shall contain less than 25% added sugar" it shall be designated as "seconds." In the grades adopted at this time by the Canners' League of California the in-going sirup for fancy, choice, standard, and seconds grades, respectively, was 55, 40, 25 and 10% sugar when packed *(6)*. The actual basis for this practice is not known and there is little comparative data on the trends in cut-outs and the proportion of the pack in sirups of various strength. Such little comparative data as are available are shown in Table 1. At present sirup strength is not a grade factor although it may be used in label designation *(16)*. Leonard *et al. (11)* found that the soluble solids-acid ratio of clingstone peaches is a good criterion of peach flavor (ratio of 25 to 32:1 was found to be optimal) and stressed fruit flavor rather than sweetness as being the most important factor determining acceptability. In recent tests, however, Simone *et al. (13)* indicated definite consumer preference for sweetness similar to that reported in the market surveys by Critchfield *(6)*.

TABLE 1
Brix degree of cut-out sirup from commercially canned peaches

Grade of fruit		Ingoing sirup °Brix	Cut-out sirup °Brix		Present designation[3]
1915[1]	1929[2]		1915[1]	1929[2]	
Extra Special	Fancy	55	26.1	24.8	Extra heavy sirup
Extra	Choice	40	22.2	21.5	Heavy sirup
Extra Standard	----	30	18.5	-----	-----
Standard	Standard	20 (25)[2]	16.1	16.2	Medium sirup
Seconds	Seconds	10	12.3	12.3	Light sirup
Water	Water	0	9.0	9.7	Water

[1] After Bitting *(4)*.
[2] After Critchfield *(6)*.
[3] After U. S. Department of Agriculture *(15)*.

Changes in varieties of peaches grown for canning, in growing conditions, and particularly in processing methods *(7)*, that have occurred since the early days make it difficult to compare the trends in canning practices. The recent introduction and widespread use of newer methods of pitting (twist or torque[b] instead of knife pitter) and particularly in lye peeling (cup-down instead of immersion peelers) have had important effects on both yield and quality.

In any comparative study such as the present, it is necessary to recognize not only the seasonal variations (which for deciduous tree crops like peaches may be quite marked) but also variations in the individual cans and halves of fruit. Uniformity in samples is of particular concern when comparisons between limited packs are made. The extent of such variations, for example, is shown in Figure 1 for variation observed in firmness of individual halves as measured in 12 cans of peaches packed in a commercial cannery and in our pilot plant at Davis in 1953. The fruit canned at Davis was carefully selected for uniformity of size, color, and composition and that canned commercially was from fruit selected from the line. Considerable variation in texture

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, June 12, 1956, St. Louis, Missouri.

[b] Filper pitter manufactured by Filper Corp., Richmond, Calif.

of the individual halves of fruit from a particular can and in cans of the same lot was observed. The experimentally packed fruit was just as variable in texture as that obtained from the line under commercial operations. At least 6 cans and preferably 12 cans of each lot were found necessary to obtain reproducible data for each factor studied. The variability is shown in Figure 2 to occur at all replacement levels of corn sirup. Figure 3 shows the summary of data on 5 lots of peaches canned commercially in 1955 during the same day. The average firmness found for 6 cans of each lot was 159.8, 182.9, 150.0, 188.6 and 206.3.

Seasonal variation due to differences in climatic conditions prevailing during the growing season, particularly at later stages of maturation, and differences in

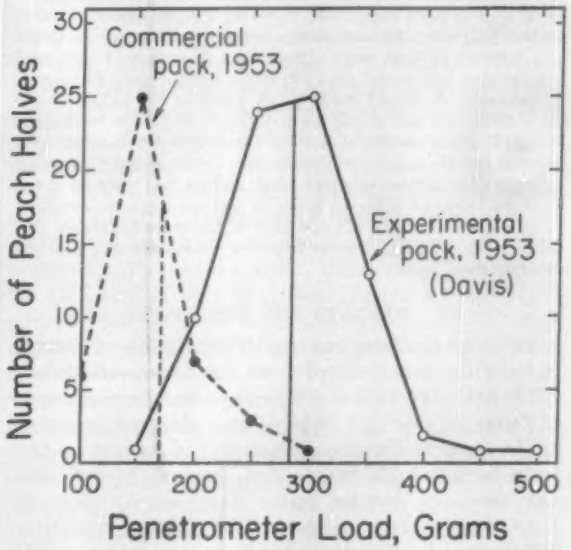

Figure 1. Variation in firmness observed in individual halves of canned clingstone peaches in lots of 12 cans each cut from samples canned commercially and in pilot plant.

variety and maturity of the fruit harvested also are known to occur. For these reasons we have made observations on fruit canned commercially during the seasons of 1952-1955 and experimentally during the seasons of 1953 and 1954. From one to 5 cases of each lot of fruit were packed for observation on cut-out weights and sirup density and for observations on appearance, flavor, and texture. A considerable amount of data was obtained and this is presented only in part in this paper in which the more important effects on flavor and texture are summarized.

EXPERIMENTAL METHODS

Fruit. Although over 10 varieties of clingstone peaches are grown in California, only 5 are grown extensively. These in order of acreage planted are: Halford, Gaume, Paloro, Phillips and Peak *(8)*. The first four were used in commercial packs during the seasons of 1952-1955. In experimental packs Halford peaches were used in most of the lots packed in 1953 and 1954. The fruit packed under commercial conditions was the larger sizes of fancy or choice grade, selected at the height of the canning season from line samples for reasonable uniformity of color and maturity. That packed in Davis was middle maturity fruit, 2½-3 inches in diameter, selected for uniformity of color and varying in soluble solids content usually from 11.3-12.6%, and in total titratable acidity from 0.54 to 0.64% and in soluble solids-acid ratio from 18.0 to 22.0.

Preparation and processing. The cannery fruit was halved, twist pitted and lye peeled in cup-down spray lye peeler by

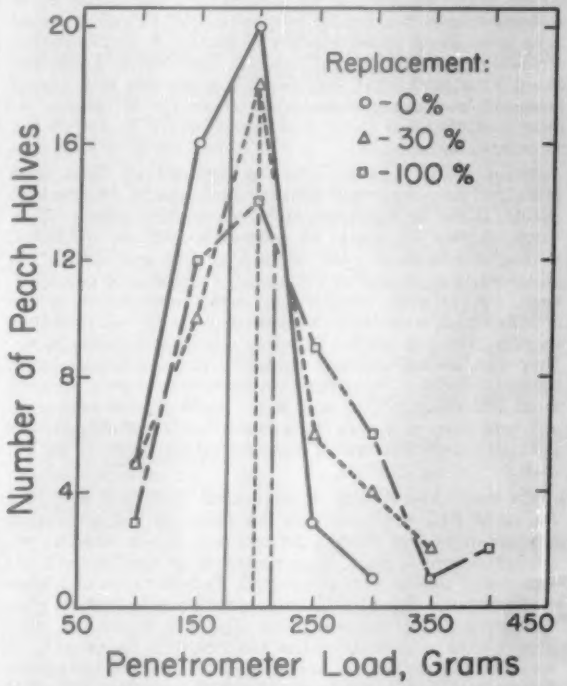

Figure 2. Variation in firmness observed in individual halves of experimentally canned clingstone peaches in lots of six cans each of fruit packed in 1953 in sirups at several replacement levels of corn sirup in distilled water.

treatment with 1 to 3% lye for one minute at 208-210° F. Experimentally, both immersion lye peeling and cup-down spray lye peeling at lye concentrations varying from ½% to 3% and temperatures from 210 to 220° F. were used. It was observed early in 1953 that the hardness of the water used in washing the fruit after lye treatment had a marked effect on firmness of texture and that the cup-down lye peeled fruit was markedly more susceptible to this than the immersion peeled.

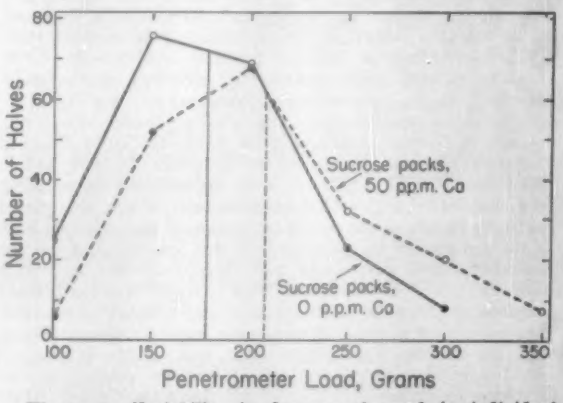

Figure 3. Variability in firmness observed in individual halves of peaches canned commercially in 1955 in sucrose sirups in distilled water with and without added calcium chloride.

Well water containing 16 p.p.m. of calcium produced a noticeable increase in firmness of the fruit in comparison with distilled water, and this was marked with water containing 33 p.p.m. of calcium. For this reason softened water was used in washing the fruit and distilled water was used in preparation of sirup. The lye peeled and washed fruit was placed in No. 2½ cans, usually 19 to 19½ oz. of fruit, and 40° Brix sirup was added to fill the can. Commercially the siruped fruit was exhausted in a steam exhaust box for 5-6 minutes at 204° F. and processed in an atmospheric pressure rotary cooker for 21 to 25 minutes, depending on the variety and season. The fruit at Davis was closed in a mechanical vacuum closing machine and usually processed in a rotary atmospheric cooker for 30 minutes although experimental packs were heated at 212° F. for 25 and 35 minutes also.

Sirups. The ingoing sirup was prepared at Davis from granulated cane sugar and various corn sirups by dilution with distilled water or tap water of known calcium content. Corn sirups varying in degree of conversion (42° to 64° D.E.), method of hydrolysis (acid hydrolyzed, acid and enzyme hydrolyzed), and method of refinement (vegetable carbon treatment, ion-exchange treatment or both) were added to the granulated sugar at replacement levels on a dry solids content varying from 0 to 100%. The sirup was diluted usually to 40° Brix with distilled water, or tap water, with and without added calcium chloride. The sirups used commercially were prepared from granulated cane or beet sugar, liquid cane or beet sugar and corn sirup at various replacement levels and diluted with tap water or distilled water, depending on the nature of the test pack.

Cut-out. The drained weight of the fruit and sirup, the equivalent Brix degree of fruit and sirup, pH and acidity was determined by the usual procedures *(1, 9)*. In addition, the calcium content of fruit tissue, cut-out sirup sugar content, and total pectin content were determined. Determination of calcium content in fruit tissue by the acid extraction and versenate titration method *(15)* was not found applicable because of interference from magnesium present and difficult in decolorizing. It was necessary to ash the samples and after ashing the calcium content was determined by the A.O.A.C. procedure *(1)*. This limited the numbers of samples that could be analyzed. Fractionation of the calcium present into free and bound by water and EDTA extraction and the simultaneous determination of calcium and magnesium was planned. While suitable methods were being explored, Bauserman and Olson's report on the feasibility of using EDTA as solubilizer for mineral analysis of plant tissue appeared *(3)*. Data on calcium and magnesium content will be reported later.

Firmness. It was observed early in our investigations that firming when it occurred was most evident in the outer skin surface area of the fruit while the flesh at the pit surface area remained soft. In freshly canned fruit it was possible to separate the outer fruit tissue as a leathery layer from the inner pit surface flesh. This difference between the flesh at the skin surface and pit surface is characteristic and usually decreases during storage. Because of this difference between the texture of the peach flesh at different positions and because of the necessity to test large numbers of individual peach halves objective texture measurements were made with a simple weight-loaded penetrometer. This was the loaded round rod, 5/32 inch in diameter, specified in the FDA standard for canned clingstone peaches promulgated on December 18, 1939, and in effect since March 17, 1940. As used, the unloaded rod weighing 50 g. was loaded with weights at increments of 50 g. and placed vertically in turn on the center top surface of each inverted half. If the rod pierced through the flesh this was noted, if not the unpierced halves were tested with successively increased loads until pierced. The maximum total weight (rod and load) required to pierce the flesh was used as a measure of firmness. Although other methods of measuring texture were considered, only the Kramer Type Shear Press was tested. It was not found applicable to canned halved peaches which presented problems in methods of loading and operation. When halved fruit was used at No. 2 speed and pressures of 0-100 lbs., the shear press values for 3 cans of fruit in comparison with penetrometer values obtained are shown in Table 2. When the halves were cut into quarters, the shear press values for fruit canned in sucrose sirup averaged 22.1 and for those canned at 80% replacement level 56.1. Because measurements with the shear press were more time consuming and not as sensitive they were not continued.

TABLE 2

Comparison of Shear Press with Rod Penetrometer [1]

Corn sirup replacement level percent	Shear press lbs.	Penetrometer grams
0	29.6	173.6
10	40.9	188.5
50	33.8	169.5
80	36.0	214.4
100	28.9	226.5

[1] Data reported by Dr. Walter Büchi.

Taste preference. The samples of Halford peaches packed at Davis in 1953 in 40° Brix sucrose-corn sirup at replacement levels of 0 to 100% were taste tested by an experienced panel of student judges at the consumer acceptance laboratory at Davis. The samples of fruit were drained, the fruit from 4 cans each was chopped and mixed with 200 ml. of cut-out sirup and served in randomly numbered beakers. A panel of 16 judges scored the samples for flavor only on a 10-point scale. An incomplete balanced block design in which 4 samples per session were presented in 15 sessions was used *(11)*. In other taste appraisals a similar incomplete balanced block design was used to determine the effect of different types of corn sirup at 25% replacement level packed in 1953 and also in the more extensive 1954 packs at various replacement levels of granulated dextrose and other types of corn sirup.

RESULTS AND DISCUSSION

Effect of replacing sucrose by corn sirup on texture. In both the fruit selected from the commercial line in 1952, 1953, and 1954 and in fruit packed experimentally at Davis in 1953 and 1954, it was observed in several different packs that the replacement of sucrose by corn sirup increased the firmness of the fruit canned when soft water or distilled water was used to dilute the sucrose-corn sirup blends to the canning strength of 40° Brix. As shown in Figure 4 for experimentally canned middle maturity Halford peaches in sirups diluted with distilled water, an increase in firmness occurred even at lower replacement levels and this increased as the replacement level was raised. This was

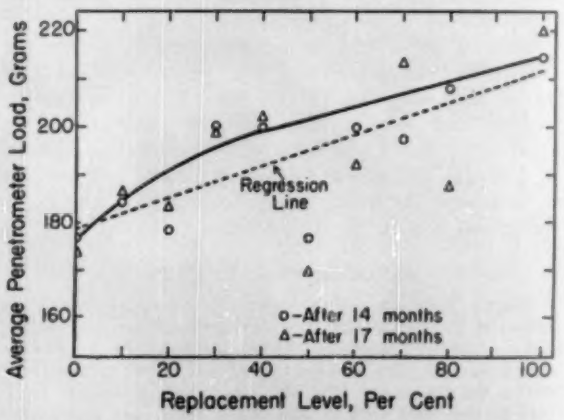

Figure 4. Effect of replacement of sucrose by canners acid converted carbon refined 55 DE corn sirup on firmness of Halford peaches canned at Davis in 1953 in sirups diluted to 40° Brix with distilled water.

found when the fruit was examined 14 and 17 months after canning. Although the average penetrometer loading shows considerable deviation from the line fitting most of the points, particularly at the 50 and 60% replacement level, the calculated regression line indicates a statistically significant increase in firmness with increase in replacement level. The sucrose used was granulated cane sugar and the corn sirup was a 43.2° Bé, 55.3 DE equivalent acid-converted, carbon refined.

It was found that the calcium content of peach flesh increased from 26.7 p.p.m. to 50.9 p.p.m. with increase in replacement level at which corn sirup was added but this increase was not regular, which explained in part the variations observed above at the 50 and 60% replacement levels. These variations could have been caused by differences in calcium content of the water used for washing the fruit.

In other series it was observed that the effect of replacing granulated or liquid cane sugar on texture varied with type of corn sirup, and hardness of the water used in washing the fruit after lye peeling and in preparing the sirups. Thus, with hard water, replacement with corn sirup of the type used above at low levels (10%) increased firmness slightly but at higher levels (20-60%) decreased firmness. With Halford peaches washed with softened water canned in sirups prepared with softened water, the average firmness at the 25% replacement level was affected less by 62DE acid-enzyme converted corn sirup than by 54 DE acid-converted corn sirup, with granulated dextrose being intermediate. At replacement levels of 50% and higher the granulated dextrose had least effect on texture.

To determine whether the effect on texture was due to the introduction of calcium by the corn sirup added or to the effect of the oligosaccharides and dextrins present in the corn sirup, seven specially prepared corn sirups varying in calcium content and saccharide composition were compared in experimental packs at Davis in 1954. At the 25% replacement levels the firmness of the peaches canned varied from 186 to 204 on the average of 6 cans of each lot tested 2 months after packing. However, in these lots there was no clear correlation between calcium content and saccharide composition and firmness; it appeared that both the calcium content and the higher saccharides present influenced firmness.

In 1955, granulated dextrose and 4 different corn sirups, varying in degree of conversion from 54 DE to 62 DE, type of conversion (acid and enzyme), carbon and resin refined were compared at 25, 50, 75 and 100% replacement levels. Liquid beet sugar was used for comparison and all sirups were diluted to strength with distilled water. In distilled water, as the data in Table 3 show, there was less difference in firmness between these corn sirups and the sucrose packs than between different lots of sucrose packs. More difference, however, was found between sucrose and sucrose-corn sirup packs at the 25% replacement level for the 52 DE acid converted corn sirup than for other sirups tested. The addition of 50 p.p.m. of calcium resulted in appreciable increase in toughening in straight sucrose packs but decreased differences between sucrose and sucrose-corn sirup packs.

Effect of added calcium. It was observed that the firmer halves selected from peaches canned in 56 DE corn sirup at the 25% replacement level in 1951 were appreciably higher in calcium content (37 p.p.m.) in comparison with peaches canned in straight sucrose (26 p.p.m.), although their magnesium content was the same (46-47 p.p.m.). The calcium content of the firmer halves was considerably higher than the average of 30 ± 10 reported by Kramer *(10)* for commercially canned clingstone peaches of the 1942 and 1943 canning season. Kramer reported the 25 samples of canned clingstone peaches analyzed after mixing the fruit and sirup to vary from 20 to 60 p.p.m. in calcium content.

TABLE 3

Firmness of Halford clingstone peaches canned in sucrose-corn sirup mixtures

Type of corn sirup	Average penetrometer loading in grams				
	Replacement level, %				
	0	25	50	75	100
	0 p.p.m. calcium added				
52 DE, Acid converted, Carbon Refined	160	203	196	176	181
52 DE, Acid converted, Carbon and Resin Refined	183	183	209	157	202
60 DE, Acid converted, Carbon and Resin Refined	150	158	172	186	191
62 DE, Acid-enzyme converted bone-char, and Resin Refined	189	192	180	176	151
Dextrose, granulated	206	197	210	190	184
	50 p.p.m. calcium added				
52 DE, Acid converted, Carbon Refined	215	191	200	.....	215
52 DE, Acid converted, Carbon and Resin Refined	203	226	247	.....	201
60 DE, Acid converted, Carbon and Resin Refined	208	238	225	.....	230
62 DE, Acid-enzyme converted bone-char, and Resin Refined	229	230	197	.....	189
Dextrose, granulated	183	184	188	.....	180

In the 1952 pack at Richmond appreciable difference in firmness was observed in peaches canned in sirups diluted with water containing 33 p.p.m. of calcium in comparison with distilled water, and in 1953 it was observed that untreated well water containing 22 to 25 p.p.m. of calcium appreciably firmed even the fruit canned in straight sucrose sirup. Water softened to a calcium content of less than 10 p.p.m. by driolite resin treatment had to be used in washing cup-down spray lye-peeled fruit to avoid toughening. The calcium content of samples of lye used in 1953 varied from less than 10 p.p.m. to over 50 p.p.m., depending on water supply and lye used, but in most cases it was less than 20 p.p.m.

In the 1952 pack at Richmond, fruit was canned in 100% sucrose and 25% 54DE corn sirup and 75% sucrose sirups diluted to strength both with distilled water and tap water containing 33 p.p.m. calcium. The peaches canned in straight sucrose sirup in distilled water contained on the average 18 p.p.m. of calcium; those in tap water which were slightly firmer, 23 (ranging from 19.0 to 27.0). In the corn sirup-sucrose blend in tap water the peaches contained 23.5 p.p.m. of calcium and were appreciably firmer. The fruit canned in straight corn sirup averaged 29.5 p.p.m. of calcium and were definitely firmer. Thus it would appear that an increase in calcium content of about 10 p.p.m. was

sufficient to produce quite appreciable increase in firmness. In another comparison clingstone peaches canned in 36° Brix sucrose and in sucrose-corn sirup blends with 60, 54 and 32 DE corn sirup at 25% replacement levels, respectively, contained 16, 18, 20 and 24 p.p.m. of calcium and increased in firmness in the same order.

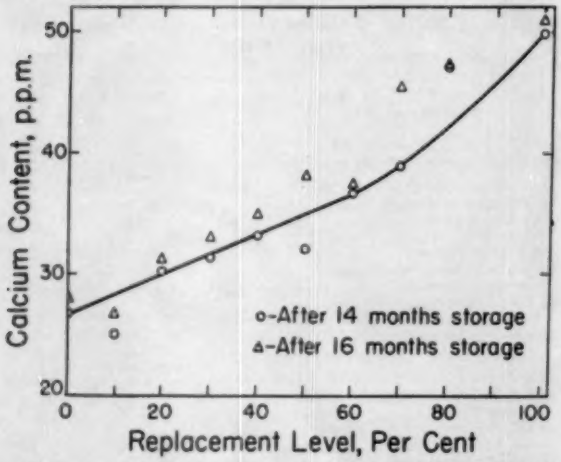

Figure 5. Effect of replacing sucrose by 54 DE carbon refined corn sirup on the calcium content in peach flesh in series canned at Davis in 1953.

In the corn sirup replacement pack of 1953, analyses for calcium in fruit flesh were made on composite samples cut out 14 and 16 months after canning. The results obtained are shown in Figure 5. In all cases the calcium content of the fruit was higher than than in the cut-out sirup.

To obtain additional information on the effect of added calcium, 3 lots of fruit were canned. The first lot consisted of Gaume peaches canned at Richmond in 1952 in distilled water at calcium levels (added as calcium chloride) of 0, 25, 50, 75 and 100 p.p.m. The second lot packed at Richmond in 1954, consisted of Halford peaches canned in sucrose sirup prepared by dissolving granulated cane sugar in distilled water and brought to 0, 25, 50, 75 and 100 p.p.m. of calcium. The third lot was similar to the second but canned in sucrose-corn sirup blend containing 25% of 54 DE corn sirup. The calcium content of the fruit several months after canning is shown in Table 4 and the texture evaluation in Figure 6. In the water pack appreciable increase in firmness was noticeable at the 25 p.pm. level, and this was quite marked at 50 p.p.m. and higher levels. Here again an increase of less than 10 p.p.m. in calcium content in the flesh produced noticeable increase in firmness. The effect of added calcium was more noticeable with sirup packs. In the straight sucrose packs the peaches became firmer on storage but firming was more pronounced at 0 added calcium than in presence of added calcium. This increase in firmness was marked after 2 months but on increased storage further appreciable changes did not occur. The average penetrometer load after 6 days was 125, after 2 months' storage it was 197 and after 8 months it was 193. In the presence of 25 p.p.m. of added calcium the corresponding penetrometer load was 169.2, 212.2 and 192.0. The addition of calcium to sirups containing corn sirup solids appears to affect texture of peaches more than that added to sucrose sirups. Peaches canned in sirups containing corn sirup solids or in sucrose sirups with added calcium do not change appreciably in firmness on storage.

TABLE 4
Calcium content of peaches canned in water and sirup containing added calcium

Calcium added to water or sirup, p.p.m.	Calcium content of fruit flesh		
	Water pack[1]	p.p.m. Sucrose pack[2]	Sucrose-corn sirup pack[2]
0	25.5	32.5	28.5
25	24.0	46.1	50.1
50	34.0	47.8	60.0
75	35.1	62.2	64.7
100	45.6	72.2	76.0

[1] Average of 3 cans sampled individually. Considerable variation occurred from can to can.
[2] Composite average of fruit from 6 cans after 2 months' storage.

Taste preference testing. The fruit and sirup were tasted periodically during the course of these investigations and it was observed that replacement of sucrose by corn sirup apparently decreased fruitiness. This effect was noticeable at the 25% level to discriminating tasters, but it was not known whether or not it would be significant to the average consumer. Decrease in sweetness also occurred and it was not known whether this would be appreciable to the average consumer and if appreciable whether it would be desirable. The flavor preference of 4 series of fruit canned at Davis in 1953 and 1954 was evaluated by an experienced student panel at Davis. In the first taste appraisal, samples of Halford peaches canned in sucrose-corn sirup blends at replacement levels of 0-100% of canners acid converted

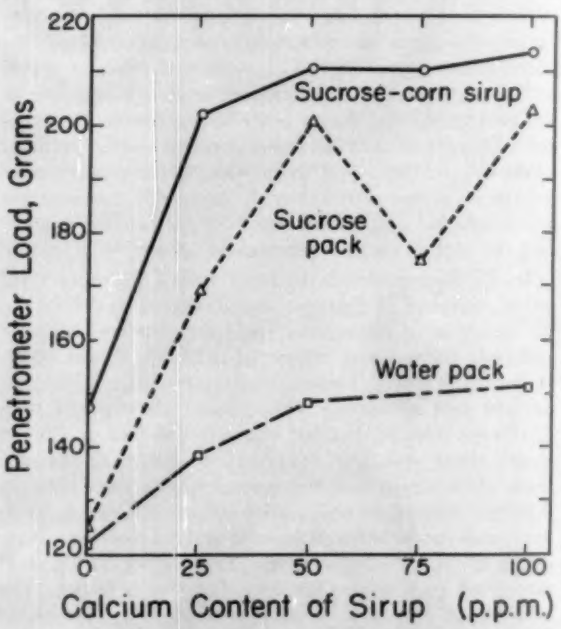

Figure 6. Effect of added calcium on firmness of peaches canned in water, sucrose and sucrose-corn sirup. The data for water pack were taken after 2 years' storage, that for sirup packs after 6 days' storage.

carbon refined corn sirup were taste tested by a panel of 16 experienced judges. Results obtained are shown in Figure 7. Taste differences were significant between the sucrose sample and the corn sirup sample only at 50% and higher replacement levels.

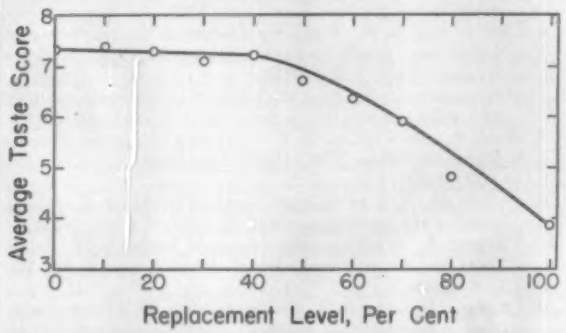

Figure 7. Effect of replacement of sucrose by corn sirup on flavor of canned Halford peaches.

In the second series, comparison was made between Halford peaches canned in straight sucrose sirups and those canned in granulated dextrose and various corn sirups at 25% replacement level. In this series granulated dextrose, 34 DE corn sirup, 42 DE corn sirup, 54 DE corn sirup and 62 DE corn sirup were compared. Of these only the acid converted carbon refined 54 DE corn sirup and the acid-enzyme converted bone char and resin refined 62 DE sirup would be used by canners. Significant difference in flavor was observed between sucrose and the sucrose-corn sirup packs with the lower conversion corn sirups and the peaches canned in the acid-enzyme converted corn sirup were preferred to those canned in sucrose.

To obtain additional data on the relative effect of granulated dextrose and corn sirups, samples of peaches canned at Davis in 1954 in blends of sucrose and granulated dextrose, 42 DE acid converted carbon refined corn sirup, 54 DE acid-converted carbon refined canners corn sirup, and 64 DE acid-enzyme converted bone char and resin refined corn sirup at 0, 25, 50, 75 and 100% levels were compared. No real differences were found between the dextrose and corn sirup and the straight sucrose pack at the 25% level but at higher replacement levels the peaches packed in sucrose sirups were significantly better. Although several judges commented on the fact that the sucrose sample was too sweet when compared with dextrose and corn sirup samples at higher replacement levels, they still preferred it. The flatness and lack of fruit flavor in corn sirup samples at higher replacement levels was noted frequently. Granulated dextrose was not found to affect loss of fruit flavor as much as the corn sirups used but contributed to a peculiar and undesirable bitterness and off-flavor. The fruit canned in dextrose sirups approached in sweetness that canned in sucrose. At the 50% replacement level the fruit canned in dextrose containing sirups scored higher than that in other sirups, being followed closely by the 64 DE corn sirup. The actual average flavor scores at 50% replacement level were: 5.36 for straight sucrose, 4.66 for dextrose, 4.32 for 64 DE corn sirup, 3.97 for 54 DE and 3.79 for 42 DE.

Finally, seven different corn sirups varying in degree of conversion (51.3 to 63.3 DE), in type of conversion (acid and acid-enzyme), and in method of refining (carbon or bone char with and without ion exchange treatment) were compared at the 25% replacement level. In these lots the bone char refined acid-enzyme converted 62 DE corn sirup was found to be higher in preference even to straight sucrose. The 54 DE acid-converted carbon refined canners corn sirup was rated equal to sucrose and the others lower. The lowest score was given to a sample of regular 52 DE canners intermediate corn sirup carbon and ion exchange refined but the differences in score were not large, varying from 4.03 to 4.77.

Since changes in both sweetness and fruitiness were observed it was desirable to determine which of these was of greater significance. Although sweetness is complicated by many factors *(14)*, a preliminary attempt to evaluate this was made by the addition of sucaryl to corn sirup packs. Peaches canned in corn sirup were brought to approximately the same level of sweetness and to slightly lower and higher sweetness than comparable peaches canned in sucrose. It was found, in general, that preference was for the sweeter sample and in only one of 3 trials was the difference in scores between any of the 4 samples significant. This would indicate sweetness to be more important than fruitiness in canned clingstone peaches.

During taste appraisal the panel also noticed differences in texture. In the first series, where the fruit was ground before presentation, changes in texture were reported only at the 40% replacement level. This was true in other tastings where the fruit was diced instead of ground. Only at replacement levels of 50% and above were texture differences apparent to judges who reported samples to be *too firm, rubbery* or *tough*.

SUMMARY AND CONCLUSIONS

The effect of replacing sucrose by corn sirup on texture and flavor of canned clingstone peaches packed experimentally in the pilot plant at Davis and in a commercial cannery was observed on packs made during five canning seasons. Considerable variability between individual halves in the same can and between cans of the same lot was observed in texture and composition even when particular care was taken to select fruit of uniform quality. Seasonal differences, and varietal differences were noticed.

A comparison of granulated dextrose and corn sirups varying in degree and type of conversion and in method of refinement was made.

Replacement of sucrose by 25% by weight of corn sirup solids caused a detectable increase in firmness and this increased as the replacement level increased. Differences in texture were noticeable to tasters usually at higher replacement levels, 40% and above, not used at present in the industry.

The calcium content of the corn sirup used appreciably affected increase in firmness of texture and significant changes in texture were correlated with

relatively small increases in calcium content of the fruit (of the magnitude of 10 p.p.m.). The clingstone peaches tested apparently were quite sensitive to calcium and introduction of calcium at any point in processing (lye peeling, washing, sirup preparation) was cumulative. The sensitivity to calcium was increased by sugars used. Some constituent or constituents of corn sirups had more effect than sucrose.

Flavor differences were observed at the 25% replacement level but usually were noticeable at higher replacement levels. The type of corn sirup used had an appreciable effect on this flavor change. The method of conversion as well as method of refining affected this change in flavor. Loss in fruitiness and decrease in sweetness was observed, but the latter appeared to be most important.

Acknowledgment

These investigations were made possible by grants-in-aid from the Sugar Research Foundation in 1953 and 1954, and by the Corn Industries Research Foundation in 1953, 1954, and 1955. In 1952 experimental packs were made under our direction by Mr. Bruno Filice at the Filice and Perrelli Cannery at Richmond and in 1955 at Richmond and Gilroy. The grants-in-aid by the Sugar Research Foundation were used to finance the canning operations and taste testing at Davis, and those of the Corn Industries Research Foundation for laboratory examinations at Berkeley and for the 1955 canning tests. We are grateful for this support and particularly for the interest that was displayed by these agencies in our investigations. Many persons assisted us in preparing these samples and obtaining the data presented. The technical assistance of Dr. B. S. Luh and Miss Marion Simone at Davis and of Dr. Walter Büchi, Dr. Aaron Lukton, Dr. Guido, De Luca, and Mr. Ray Binder and David Jacoby at Berkeley is particularly acknowledged.

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Inspection Frequencies and Sample Numbers for Raw Materials Procured For Food Processing[a, b]

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(Manuscript received June 23, 1956)

THE SAMPLING INSPECTION OF RAW MATERIALS is a well established part of the quality control operation in many food processing plants. All too frequently, results of such inspection are taken at face value. It is assumed that the test value is identical with the true average value of the lot tested. Or, even more erroneously, the unit tested is assumed to be identical with each and every unit in the entire lot. These erroneous assumptions are not shared by many workers familiar with the inherent variability existing in biological material; they realize that inspection results become more representative of the lot as the frequency and size of sampling are increased. At times such workers strive to increase inspection work to the maximum allowed by management. This approach may be wasteful, since an optimum inspection procedure should provide an estimate of lot quality at the minimum acceptable level of accuracy at the least cost. Such an optimum procedure may be selected only by the use of certain statistical tools. It is the purpose of this presentation to indicate the factors which influence the choice of specific

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 11, 1956.

[b] Scientific Article No. A562, Contribution No. 2719, of the Maryland Agricultural Experiment Station (Department of Horticulture).

sampling plans for specific purposes, and to outline some rapid statistical procedures by which these sampling plans may be constructed.

DEFINITIONS

Before entering into a discussion of the problem, it may be well to define some of the terms encountered in sampling studies.

Attributes and variables. Inspection by *attributes* consists of classifying a unit of a product simply as acceptable or unacceptable, whereas inspection by *variables* refers to actual values obtained in terms of some scale used to establish the level of the quality factor.

Critical, major, minor. These terms refer to the importance of the quality characteristic to be inspected. In food products a *critical* characteristic, may be defined as one which may constitute a health hazard to the consumer, such as the presence of toxic substances. A *major* characteristic is one which, while not directly injurious to health, may cause the product to be unsuitable for human consumption, such as presence of insect material in processed foods. A *minor* characteristic may be one which might cause a change in the economic value of material which is fit for human consumption. Another possible distinction between *major* and *minor,* may be predicated on the ease with which the defect may be sorted or trimmed out of the food product during the manufacturing process.

Normal, tightened, reduced. These terms refer to the degree of risk that the buyer is willing to assume in sampling inspection. Where the buyer wishes to minimize his risk, he will use *tightened* inspection, and thereby reduce sampling error, while incurring higher inspection costs. If, perhaps because of confidence in the supplier, he is willing to take a greater than *normal* risk, he may use *reduced* inspection.

Bulk, sub-lots. These terms refer to the character of the lot. A *bulk* lot is one in which the units of the product are not packaged in any way; *sub-lots* refer to sub-divisions of the lot in pallets, crates, cartons, etc.

THE INFLUENCING FACTORS

The factors which influence the sampling procedure to be selected may be listed as follows:

1. Purpose for which the inspection is made.
2. Nature of the material to be tested.
3. Nature of the testing methods.
4. Size, packaging and load characteristics of the lot.

Purpose. All inspection is not done for the same purpose; hence, sampling plans must be selected which are capable of achieving the specific intended purpose.

Accept or reject. This situation is encountered where the processor is offered a lot for sale, and he may decide whether he will or will not buy the lot. In such cases an attributes sampling plan is frequently suitable.

Evaluate average quality. In many instances there is no opportunity to reject lots, so that the quality level is determined primarily for the purpose of establishing payment on the basis of a predetermined sliding scale. Here actual measurements must be made so that a variables plan may be required.

Determine uniformity. Particularly where discrete units are packed rather than blends, the variability existing in a given lot is as important as average quality. Here again a variables plan is indicated.

Nature of material. *Homogeneity.* Where an essentially homogeneous material is to be sampled, such as a true solution, one small sample is sufficient. As variability among units of the lot increases, there is need for increasing the number of units comprising the sample in order to have the sample representative of the lot.

Unit size. With liquid or semi-liquid products, and with products consisting of small particle sizes, there is the need for establishing some discrete sample unit size, such as the volume of a container, or the contents of a probe. Where the unit size is larger, as for example an ear of corn, that unit may serve directly as a sample unit. Where the units are very large, such as a side of beef, it may be necessary to determine exactly how, where, and how much of the unit is to be removed for sample.

History of material. Whatever is known of the history of the lot should be considered in setting up a sampling procedure. Sampling may be reduced if it is known that the lot originates from a reliable source. If the lot is part of a larger batch which had already been sampled repeatedly, sampling may be greatly reduced or even eliminated entirely for some lots. On the other hand, if the lot originates from a questionable source, sampling may be tightened.

Cost of material. Where the raw material itself constitutes a substantial part of the sampling cost, it may be necessary to restrict the amount used for sampling purposes. For this reason, for example, crab meat samples may be smaller than tomato samples.

Nature of test procedures. *Importance of the test.* All tests may be classified as being of critical, major, or minor importance. Inspection for critical factors, that is, factors that may have an effect on the health of the consumer should be sampled and tested more rigorously than major factors which do not constitute health hazard, but are of major economic importance. Factors of only minor importance may be sampled less thoroughly.

Destructive or non-destructive. Particularly where the raw material is costly, sampling procedure may be reduced if the test procedure is destructive of the material tested. Thus, for example, peas tested for texture with a tenderometer, may no longer be used, while asparagus examined for white butts, may be returned for processing.

Time and equipment consumption. A test that is time consuming and ties up elaborate and costly equipment and personnel is more costly to perform than some rapid, simple test. This must also be considered in setting up the frequency and size of sampling.

Lot characteristics. *Size.* Accuracy of sampling is related almost entirely to the number of samples tested rather than to size of the lot. However, since more is involved with larger lots, it may be desirable to increase sampling accuracy for larger lots, so that larger sample numbers would be justified with increasing lot size.

Sub-lots. Raw material frequently arrives at the processing plant not in bulk, but in some form of packaging. In such cases the added problem of how many units out of how many sub-lots are to be drawn, presents itself.

Loading. The manner in which the lot is stacked or loaded may present a problem in the random selection of sample units. The principle of randomness is basic to proper sampling. Every unit must have equal oppor-

tunity for being drawn. Where it is impossible or impractical to draw sample units from any location but the top or the end of a load, special facilities or arrangements must be made to overcome such difficulties.

The factors which influence the selection of a sampling plan are summarized in Table 1.

PROCEDURES

The procedure by which a sampling plan is to be selected will differ, depending on whether or not an attributes or variables plan is required, and whether or not the lots to be tested arrive in bulk or packaged into sub-lots.

Attributes, bulk lots. Since attributes procedures are relatively easy to apply, it is well to consider their use, provided, of course that the influencing factors are of such a nature that the requisites for their use are satisfied in whole or at least in large measure (Table 1).

A number of attributes sampling plans are available. One of the most commonly used is described in Military Standard 105A *(3)*. Upon determining the lot size, the acceptable quality level (AQL), precision level required, sample numbers, and the limits for accepting or rejecting the lot, may be found by reference to tables. The risk taken by the vendor and the buyer may be determined by reference to operation characteristic (OC) curves accompanying the tables.

Some typical situations where attributes plans are applicable are in the sampling of supplies other than the raw food materials, such as cans, glass containers, cartons, labels, or in sampling for visual defects, such as insect or rodent damage, presence of foreign matter, diseased or discolored spots, etc.

For example, a load of sweet potatoes contains approximately 50,000 individual roots. The processor agrees to accept the load provided there is not more than 1.0% rotted roots. The single, normal inspection level is used. Entering Table III of Mil Std. 105A *(3)*, we find code letter 0 for lot size of 22,001 to 110,000. Entering Table IVA, we find the sample size of 450, and at an AQL level of 1.0, 10 for acceptance, and 11 for rejection. In application—we draw at random 450 roots from the load, *accept* the load if 10 or less roots are rotted, *reject* if 11 or more of the 450 roots are rotted.

Attributes, sub-lots. If the same quantity of sweet potatoes does not arrive in bulk but in 100 crates, each crate containing approximately 500 potatoes, we are faced with the problem of how many roots out of how many crates to remove for the sample. Referring again to Table III, we find the code letter F for lot sizes of 66 to 110. Entering Table IVA, we find that 15 crates should be sampled. Dividing 15 into 450, we arrive at a sampling plan in which 30 roots are drawn from each of 15 crates.

If there is good reason to suspect substantial variability in the percentage of rot among crates, a screening procedure may be resorted to by which each crate (consisting of 500 roots) would be sampled separately. In this case, code letter I would be used, so that 50 roots from each crate would be examined, and the crate accepted if only one or none of the roots showed symptoms of rot.

Variables, bulk lots. Where a variables plan is indicated, the variability inherent within lots must first be estimated before a sampling plan may be established on the basis of the precision desired, and the cost involved. This variability may be estimated in terms of the standard deviation among individual units within the lot, and expressed as percent error. If this percent error is based on two standard deviations, it may be assumed that the true mean of a lot will not differ by more than plus or minus the percent error term in at least 95% of the lots tested.

A quick, approximate, method for obtaining this error term is suggested as follows:

1. Obtain at random 10 units from the lot, and test each unit by the prescribed test procedure.
2. Subtract the smallest of these 10 values from the largest, to obtain the range among the 10 units. Multiply this range by 0.65. This may be used directly as the error term, or it may be divided by the average of the 10 values and used as the percent error term.
3. Repeat steps one and two for as many lots as practicable, and obtain an average error term.
4. Determine the number of units which will constitute a sample of the desired precision by reference to Figure 1.

For example, lots of cantaloupes are to be sampled for sweetness by the use of a hand refractometer. The desired precision is ±0.5% sucrose equivalent, with confidence limits of 95% (the mean value should be within ±0.5% of the true average of the lot at least

TABLE 1

Summary of factors influencing selection of sampling plans.

Factors	When to use:					
	Attributes	Variables	Increased sampling frequency	Reduced sampling frequency	Increased sample numbers	Reduced sample numbers
Purpose of inspection	Accept or reject	Evaluate	Measure uniformity	Measure average quality	Increase precision	Reduce cost of sample
Nature of the material	Inexpensive	Costly	Variable	Homogeneous	Variable small units. Unknown history. Inexpensive	Homogeneous-large units. Known history. Costly
Test procedures	Non destructive. Rapid	Destructive. Time consuming	Less precise	More precise	Critical. Rapid	Minor. Time-consuming
Lot characteristics			Sub-lots	Bulk	Large	Small

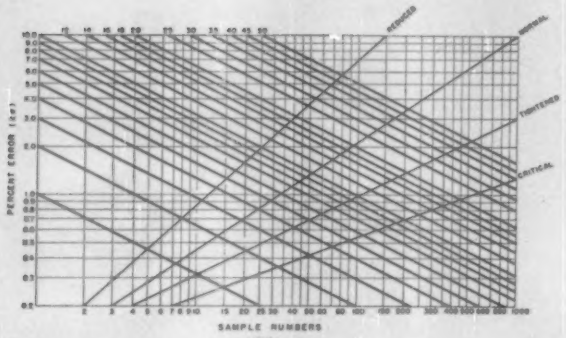

Fig. 1.

95% of the time). The procedure for setting up a sampling plan would be as follows:

1. Refractometer readings on 10 cantaloupes obtained at random from a lot are:

11.5	12.4
11.8	13.0
10.4	11.3
11.9	10.8
10.1	12.2

2. Since 13.0 is the highest value, and 10.1 the lowest, the range for the above ten values is 13.0-10.1, or 2.9, which multiplied by the factor of 0.65, yields the error term of 1.89.

3. Repeating the above process on ten separate lots, the following error terms were obtained:

1.89	2.08
1.96	2.12
2.03	1.97
1.84	2.12
2.00	1.99
SUM	20.00, or mean error = 2.00

4. We now enter Figure 1, and find the line for 2.0 error. We move diagonally down this line until it intersects with the horizontal 0.5% line. Moving down vertically from this intersect, we find that sample number of 16. We may therefore conclude that a sample of 16 cantaloupes is required to obtain an accuracy of 0.5% solids.

Variables, sub-lots. If the above cantaloupes are not transported in bulk, but in crates, say of 12 cantaloupes each, we are faced with a decision as to how many cantaloupes out of how many crates constitutes the most economic sample. It may be assumed that sampling error will be reduced as the number of sub-lots from which a fixed number of cantaloupes is drawn, is increased. On the other hand, the cost will increase as more crates are handled. Thus the problem is to determine at what point does the increasing cost of handling additional sub-lots (crates) begin to outweigh the reduction in sampling error. The procedures for setting up such sampling plans for asparagus *(1)* and tomatoes *(2)* have been reported previously.

For the cantaloupe problem, we may begin by selecting a priori, a series of sampling plans, as shown in columns 1 and 2 of Table 2, where the number of crates from which 24 cantaloupes are removed varies from 2 to 24. We use each of these seven plans in duplicate on as many lots as practicable, and calculate the standard deviation between duplicates for each of the seven plans separately (Table 2, column 3). Frequently, the curve of closest fit between number of sub-lots (crates) tested and the standard error follows a log line *(1, 2)*. We now estimate sampling cost in terms of minutes required to obtain each type of sample, and to perform the analysis (Table 2, column 4). In this case, it was estimated that 15 minutes are required to plug the 24 cantaloupes and obtain the sweetness values by the use of a hand refractometer, and 5 minutes to remove, open, and return each crate. In order to reduce all the sampling plans to a common error, we determined how many times we would need

TABLE 2

Relative efficiency of different sampling plans for estimating sweetness of lots of cantaloupes packed in crates

1	2	3	4	5	6
No. of crates	No. of units from each crate	Standard error (s)	Cost as minutes of labor	Sample frequencies for 0.5% error $(N)^1$	Efficiency index[2]
2	12	1.15	25	5.3	133
3	8	1.00	30	4.0	120
4	6	0.90	35	3.2	112
6	4	0.75	45	2.3	103
8	3	0.67	55	1.8	99
12	2	0.60	75	1.4	105
24	1	0.53	135	1.1	145

[1] Calculated as $\left(\frac{s}{0.5}\right)^2$.

[2] Calculated by multiplying columns 4 x 5.

to repeat each sampling procedure in order to arrive at a given error value. In this instance we select the error term of 0.5%, and obtain the number of samplings required to reduce the error to 0.5% (Table 2, column 5) by the following equation: $\left(\frac{s}{0.5}\right)^2$, where s is the value shown in column 3. All that now remains to be done, is to multiply the values in column 5 by the values in column 4, to obtain a relative efficiency index (column 6). Since we wish to select the least expensive plan, we may conclude that 3 cantaloupes removed from 8 crates constitutes the most efficient sampling procedure.

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Properties and Food Applications Of a New Packaging Film[a]

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(Manuscript received June 23, 1956)

PARALLELING THE OUTSTANDING GROWTH of the food industry has been the development and application of flexible materials to the packaging of food products. As is the case with all packaging materials, flexible films have had limitations. For example, processing food products in transparent flexible materials has long been a sought-for goal, but can only now be realized.

"Mylar" polyester film, although it too has limitations, has properties which will allow far greater latitude in packaging applications than has ever been possible before with a flexible transparent material. Basically, "Mylar" polyester film is prepared from the condensation polymer of ethylene glycol and terephthalic acid. "Dacron" polyester fiber, chemically similar to "Mylar," is extruded as filament; "Mylar" is produced in continuous sheets and is available in gauges ranging from ¼ mil to 7.5 mils and in roll widths from ½ inch to 55 inches.

"Mylar" is an oriented film of polyethylene terephthalate. This orientation is carried out in such a way that the sheet is "balanced." That is, the properties are uniform in all directions in the sheet. Most of the properties of the film are dependent upon this orientation. Unoriented polyethylene terephthalate does not exhibit all of the desirable properties associated with "Mylar" polyester film. Since "Mylar" is made from a thermoplastic polymer, its orientation can be destroyed by heating to the melting point. Fortunately, the melting point is sufficiently high, above 250° C., so that this phenomenon should present no difficulties in conventional food processing or handling.

PROPERTIES

A summary of the fundamental properties can serve as the best means of defining general performance possibilities of the film.

Mechanical properties. "Mylar" polyester film has a tensile strength at 25° C. of approximately 23,500 p.s.i. For comparison, that of machine steel is 75,000 p.s.i. In Table 1, tensile modulus, tear strength, flex life, impact strength, yield point and tensile strength of "Mylar" is compared with other packaging films.

Moisture absorption of the film is less than 0.5% (water immersion —25° C. — 1 week) and mechanical properties remain essentially constant over the entire humidity range. From a practical packaging standpoint, the film provides excellent durability under a wide variety of temperature and humidity conditions. Hard candy, pretzels, bony meats, noodle and macaroni products, frozen foods, etc., represent some of the foods wherein the toughness of the film can be put to good use. Although tear resistance of "Mylar" film does not compare with softer, more elastic films, it nevertheless is at a satisfactorily high level.

The film though rigid, with a modulus of about 600,000 p.s.i., still has a high flex life. It contains no plasticizers or softeners. Thus, flexibility as well as other physical properties is far less sensitive to changes in temperature and humidity.

Thermal properties. Although prolonged exposure to elevated temperatures (150° C. and up) tends to decrease the mechanical strength of the film slightly, the degradation which occurs is of no particular significance from a packaging standpoint. The film strength is still at a remarkably high level. Figures 1 and 2 serve to illustrate this point.

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technology, June 12, 1956.

TABLE 1
Comparison of the properties of "Mylar" polyester film with those of other Du Pont films (25° C., 35% R.H.)

Property	"Mylar"	Cellulose acetate	Cellophane
Thickness, Mils	1.0	0.88	1.0
Tensile Strength, p.s.i.	23,500	9000	8000
Elongation, %	70	20	30
Tensile Modulus, p.s.i.	500,000	350,000	400,000
Tear, Gms.	18	4	5
Impact, Kg.-Cm.	90	10	15
Flex, Cycles	20,000	300	600

In addition to stability at high temperatures, the film also performs well upon exposure to low temperatures (—80° F.). Film samples were not embrittled even at liquid nitrogen temperatures (—300° F.).

The practical implication which can be drawn from the above data is that food products packaged in "Mylar" film can be cooked, processed, and reheated in the package. This is already a commercial fact. A detailed account of the first such application has been described *(1)*. A restaurant in New York is now packaging several of its most famous meat dishes in a "Mylar"/polyethylene lamination. The product is frozen and reheated for serving by placing the entire pouch in hot water for 12 minutes. This application aptly demonstrates the versatility of

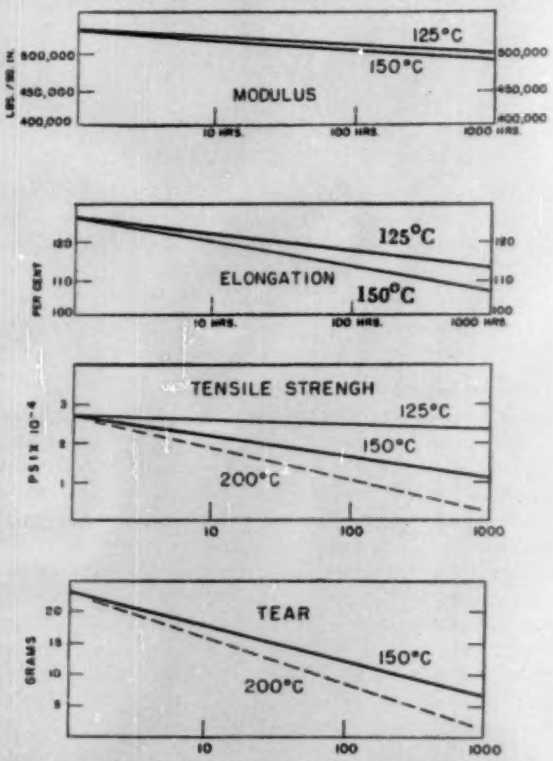

Figure 1. Effect of heat aging in air on the physical properties of "Mylar" polyester film.

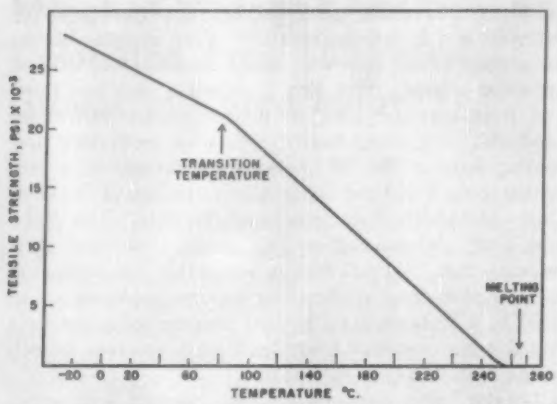

Figure 2. The change of the tensile strength of "Mylar" with change in temperature.

the film. The film can be used satisfactorily at low temperatures as well as at high temperatures.

Hu, Nelson, Legault, and Steinberg *(2)* evaluated a variety of flexible films to establish their application to heat-processed foods. "Mylar" polyester film and Trithene film were selected as suitable for additional study. The more important advantages of cooking, processing, or reheating in a transparent flexible package are as follows:

(a) Original flavors are retained.
(b) Loss of vitamins and minerals is minimized.
(c) Product shrinkage is minimized.
(d) Product odor is confined within the package.
(e) Convenience to the ultimate consumer.

Produce items such as corn on the cob, carrots, turnips, squash, etc., sauces, poultry and fish specialties, etc., have been processed or reheated in "Mylar" film packages with excellent results.

Chemical properties. Table 2 illustrates the resistance of "Mylar" film to chemicals and solvents. Many food products are packed in syrups, brines, or in themselves are composed of chemicals which exert a degrading or corrosive effect on the packaging material. The inertness of "Mylar" film to chemicals and solvents can be utilized in several ways.

Development work is now in progress to evaluate the feasibility of lining cans with thin gauges of the film, thus minimizing the need for specialized enamels. Liquid packs such as pickles in brine, etc., can be satisfactorily packaged in "Mylar" laminations.

This review of general properties should suffice to characterize the film. Attention will now be focused on those properties which are of fundamental importance in packaging.

PACKAGING PROPERTIES

Permeability. The moisture permeability is shown (Tables 3 and 4) for the film at various thicknesses and at two temperatures, corresponding to accelerated room conditions and refrigerated display case conditions.

TABLE 2
Chemical resistance of "Mylar" polyester film (1 mil)

	Resistance	Days immersed[1]	% Tensile strength retained	% Elongation retained
Acids				
Acetic, Glacial	Excellent	33	75	107
Hydrochloric, 18%	Excellent	18	82	99
Bases				
Hydroxide, Sod. 10%	Excellent	33	83	30
Solvents				
Acetone	Excellent	33	63	151
Ethyl Acetate	Excellent	33	90	132
Trichlorethylene	Excellent	33	66	84
Xylene	Excellent	33	91	151
Control			100	100

[1] At room temperature.

TABLE 3
Moisture permeability of "Mylar" polyester film (39.5° C./53 mm. Hg. vapor pressure differential)

Thickness (Inches x 10^{-3})	M.V.T.R. (gms./100 sq. m./hr.)
0.50	212
1.00	110
2.00	52
5.00	22

TABLE 4
Moisture permeability of "Mylar" polyester film (Refrigerated display case—4.4° C./2.2 mm. Hg. vapor pressure differential)

Thickness (Inches x 10^{-3})	M.V.T.R. (gms./100 sq. m./hr.)
0.50	20
1.00	8
2.00	3
5.00	1

Comparative values in Table 5 show "Mylar" to be more permeable than cellophane but similar to polyethylene in equivalent thicknesses in water vapor transmission.

Although the moisture permeability of the film at room temperature is relatively high, it borders on complete impermeability at 32° F. and below. The film offers excellent protection to frozen foods. Frozen poultry, fruits and vegetables packed in 50 gauge "Mylar" film and held for 12 or more months at 0° F. or below have remained in excellent condition.

The gas barrier characteristics of the film are satisfactory for many applications. Comparative data is tabulated in Table 6. It can be seen that changes in humidity result in relatively minor changes in permeability.

Where extreme gasprooofness is required, the film can be combined with other materials to achieve this end. The vacuum packaging of luncheon meats may serve as an example. Preliminary laboratory and field work to date indicates that "Mylar" in combination with other good barrier materials such as vinylidene

TABLE 5
Water vapor permeability of "Mylar" in comparison to that of other thin films

	Permeability Gms./100-sq. m./hour 1 Mil Thickness- 39.5° C.-53 mm. Hg. VPD
Moistureproof Cellophane (MSAD)	30
"Mylar" Polyester Film	115
Polyethylene	115
Cellulose Acetate	5000

TABLE 6
Gas permeability[1] of "Mylar" polyester film

Film	Carbon dioxide		Oxygen	
	2% RH	100% RH	2% RH	100% RH
1 Mil Moistureproof Cello.	4.73	44.29	0.58	18.91
0.5 Mil "Mylar"	3.15	11.03	1.72	4.58
0.5 Mil "Mylar"-2 Mil Poly.	.....	.....	0.71	1.43

[1] In gms./100 sq. m./hr. at 75° F.
v.p.d.—760 mm. Hg. at 0% RH
v.p.d.—738 mm. Hg. at 100% RH

chloride polymers substantially improves normal color maintenance of luncheon meat when compared to film combinations currently used. Inert gas packaging of nuts, cheese, etc., is also possible with "Mylar" film combinations.

Satisfactory resistance to the passage of odors is another feature of the film. The time in hours for various aromatic chemicals to permeate a 1 mil "Mylar" film, as noted by olfactory perception, is shown in Table 7. From a practical standpoint, this resistance to odor transmission could be of value in packaging spices, flavoring agents, soup mixes, and other food products with volatile flavors and odors.

TABLE 7
Odor permeability time in hours to penetrate

	1 Mil "Mylar"	1 Mil 300 MSAD Cellophane
Vanillin	141	20
Pinene	140	20
Methyl Salicylate	116	24
Ethyl Butyrate	20	⅓
Propylene Diamine	92	1

With regard to light transmission, the film transmits more than 90% of the incident light in the visible region of the spectrum. In the ultra violet range, it cuts off sharply at 3150 Angstroms as shown in Figure 3. In the biologically active region of the spectrum (2,950-3,150 Angstroms) "Mylar" absorbs strongly and thus differs from cellophane which transmits in this region. The film is similar in behavior to window glass with respect to ultra violet light transmission.

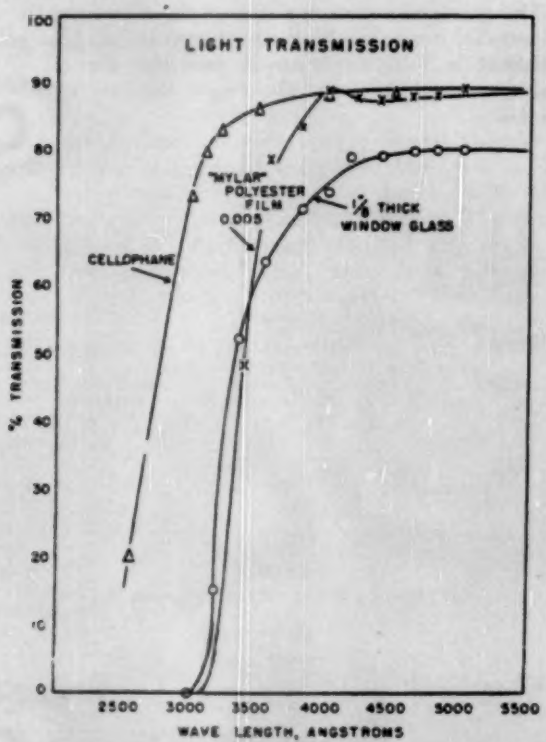

Figure 3. Light transmission of "Mylar" compared to that of other transparent materials.

"Mylar" film has exhibited excellent resistance to bacterial and fungal degradation. Film samples buried in contaminated soil for many months showed no apparent effects. The film is odorless and non-toxic and thus may be used in direct contact with food products. Regarding toxicity, data on extraction and feeding tests of "Mylar" polyester film have been presented to the Food and Drug Administration of the U. S. Dept. of Health, Education, and Welfare. The Food and Drug Administration has stated that these data indicate that "Mylar" film is acceptable for packaging in food and drug applications for temperatures up to 250° F. Clearance for "Mylar" film on meat products has also been received from the Meat Inspection Branch of the U. S. Dept. of Agriculture.

"Mylar" film and combinations thereof with other materials have been exposed to pasteurizing as well as sterilizing doses of irradiation without effect on the mechanical or physical properties. The high temperature stability of "Mylar" film has, as might be expected, presented problems in heat sealing the material by conventional means. Heat sealability is of prime importance in converting any flexible material and thus making it available in usable form.

Considerable progress has been made in developing techniques to seal "Mylar" film. Hot wire or hot knife methods have shown promise in applications where impact strength is not a critical factor. Benzyl alcohol in combination with heat and pressure is particularly promising both in terms of seal and impact strength and adaptability to machine handling. Toxicity clearance has also been obtained through the Food and Drug Administration for the use of benzyl alcohol in bag-making for food applications. Another sealing technique which is proving to be of definite value is the use of adhesives or heat sealable coatings printed in specific areas of the film where the seal is to be made. Through the use of these sealing methods, the film can now be obtained commercially in tube and bag form.

Sealing methods already discussed also make it possible to use the film on semi-automatic or fully automatic overwrapping and bundling equipment *(3)*.

Window cartons using "Mylar" film are also available and are being used on a variety of food products.

Finally, the film can be formed in a variety of container shapes and sizes. Because of its high orientation, high melting point, and high strength, vacuum or pressure forming is more difficult than with films conventionally used. A considerable amount of development work remains to be done in this area. Printing by flexographic and gravure techniques is readily and satisfactorily achieved with inks specifically developed for the film.

SUMMARY

The properties and food packaging application of "Mylar" polyester film (oriented polyethylene terephthalate) have been presented. Mechanical, thermal, and chemical properties have been described. Special emphasis has been given to the versatility of the film for packaging uses. The melting point of the film, above 250° C. permits cooking, processing, or reheating food in the package.

Effect of Storage Conditions on Loss of Color and Free Sulfhydryl Groups in Cured Meat[a, b, c]

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(Manuscript received June 23, 1956)

IN PREVIOUS WORK published elsewhere *(7)* the role of sulfhydryl groups in development and retention of a desirable color in cured meats was brought out. In addition to these reducing groups free nitrite was also found to be important for color retention upon exposure to light or restoration of color in the dark. The study reported here was undertaken with the dual purpose of investigating (a) the effect of temperature, light and packaging material on the loss of color and sulfhydryl groups in cured meat products, and (b) the relation between the susceptibility to light fading of various commercial cured meat products and their content of nitrite and sulfhydryl groups.

METHODS AND MATERIALS

Sulfhydryl groups and color were determined as previously described *(7)*. Nitrites were determined with a modification of a simple spot test *(1)*. Equal volumes of sulfanilic acid in acetic acid and alpha-naphthylamine were mixed and a few drops of this mixture put on filter paper. This was subsequently placed upon the meat surface. The intensity of the cherry red color that develops in the presence of nitrites is taken as an indication of the concentration. The application of the reagents directly upon the meat surface was found to be a less sensitive test. Moreover, the color intensity is difficult to evaluate on a pink meat surface.

The products used in this study were all commercially cured meats obtained on the local market. For much of the work on effect of storage conditions, a canned comminuted cured meat product (Prem) was used because this product could be cut into uniform slices for experimental treatments, whereas hams, bacon, and other non-comminuted meats varied considerably from muscle to muscle.

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 12, 1956.

[b] This research was financed in part by a grant from Swift and Co. to the Florida State University.

[c] Part of a dissertation submitted by A. M. Erdman to the Graduate School of Florida State University, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

EXPERIMENTAL

Effect of temperature. Canned comminuted pork (Prem) with free sulfhydryl groups but a negative nitrite test was sliced evenly and divided into nine batches. Each batch was submitted to one of the following treatments:

1. Stored without pretreatment at one of three storage temperatures,
2. Stored after a 20 second dip in a 2% nitrite solution,
3. Stored after a 20 second dip in a 0.2% nitrite solution

Each slice was wrapped individually in polyethylene, each batch in aluminum foil to prevent access of light. The three storage temperatures were: —25° C., 4° C., and 26° C. At various time intervals color and sulfhydryl groups were tested. Results are given in Table 1.

Effect of light in frozen meats. Canned comminuted pork (Prem) was sliced and submitted to the same treatments as described in the previous experiment. After wrapping each slice in polyethylene they were placed in a continuously illuminated freezer: temperature —25° C., light intensity 60 foot candles. After various storage periods color was rated and the nitroprusside test for SH groups made. Results are given in Table 2.

Effect of packaging material. Two types of cured meat, one with many free SH groups [canned comminuted pork (Prem: nitroprusside test + +)] and one with very little free SH groups (bologna: nitroprusside test ±) were sliced and exposed for 3 days to 40 foot candles light intensity at room temperature (25° C.) Half of the slices were covered with Saran, the other half with polyethylene (1.5 mm. thickness). The wrapping material was pressed down on the meat so that a close contact existed at the areas observed. A second batch

TABLE 2
Color and SH losses of Prem in a lighted freezer[1]

Concentration of NO_2 dip	Time for complete loss of SH groups (days)	Color rating at various time intervals (days)							
		1	2	4	8	21	42	56	180
No Dip	>180	6	2	0	0	—1	—1	—1	—8
2%	<180	10	6	5	2	1	1	0	—3
.2%	180	10	5	0	1	0	0	0	—8

[1] Temperature —25° C.

TABLE 1
Effect of temperature and nitrite on color loss and sulfhydryl groups in Prem

Concentration of nitrite in dip solution	Storage temp. (° C.)	Time for complete loss of SH groups (days)	Color rating[1] after various storage times (days)							
			1	2	4	8	21	42	56	180
No Dip	—25	>180	8	6	5	6	6	4	1	—8
	4	35	6	4	1	1	0	—1	—3	---[2]
	26	2	2[3]	3[3]	—1	---[2]	---	---	---	---
2%	—25	>56 <180	10	8	7	8	8	8	7	8[4]
	4	8	10	10	8	3	—1	—1	—5	---[2]
	26	1	3	—2	—3	---[2]	---	---	---	---
.2%	—25	>180	10	8	7	9	9	8	8	8
	4	56	10	10	9	9	8	8	7	---[2]
	26	3	9	9	0	---[2]	---	---	---	---

[1] 10 represents color of freshly exposed surface, 0 the color of the ferric hemochromogen, and —10 the color after complete porphyrin ring destruction.
[2] Spoilage.
[3] Uneven color.
[4] Spotty in places —10.

of slices was covered in the same way and kept in the dark at the same temperature. They formed the controls. The experiment was repeated with slices of the same products dipped for 20 seconds in a .2% NO_2 solution prior to illumination. The color was rated at regular time intervals and the nitroprusside test done at the same time. Results were virtually the same for both meats tested. Those for the Prem are summarized in Table 3.

Relation between nitrite content, sulfhydryl groups and color fading in cured meat. Eight different kinds of commercially cured meats were tested for free nitrites and sulfhydryl groups. The results of these tests varied a great deal. The products were then sliced and exposed to incandescent light of two intensities for different lengths of time. All slices were covered with polyethylene which was firmly pressed down on the meat surface. The color was visually evaluated after illumination. Table 4 gives the results.

TABLE 4
Effect of nitrite and sulfhydryl content on color fading of cured meats

Product	SH	NO_2	Visual score after 1 hr. 200 f.c.	Visual score after 4 hrs. 15 f.c.
Liver Cheese	+	+	7	8
Bologna 1	+++	+	9	6
Bologna 2	−	+++	4	1
Canadian bacon	+++	−	2	8
Comminuted Canned pork	+++	−	2	4
Ham	+++	+++	7	7
Canned ham	+++	−	4	4
Salami	+++	+++	8	9
Frankfurters	+	+++	7	8

DISCUSSION

Temperature seems to be the most influential of all factors tested on the loss of sulfhydryl groups in cured meat. Table 1 gives the time required for complete loss of all free SH groups in the untreated and nitrite dipped product. In all samples an increase in storage temperature resulted in an acceleration of these losses. The deleterious effect of the 2% nitrite solution on the sulfhydryl groups, noted in previous work *(7)* is noticeable at all temperatures. The weaker nitrite solution had a slight protective effect at all temperatures.

The rapid color fading of all samples stored at room temperature is noteworthy, especially since all slices were kept in the dark. This fading parallels the sulfhydryl losses and seems to be a consequence thereof. Bacterial spoilage was not apparent until after 4 days; however, it might have been responsible for the uneven color obesrved in the untreated samples stored at room temperature *(2, 6)*.

Both nitrite concentrations protected the meat color in the presence of free SH groups. At temperatures above freezing the correlation between sulfhydryl losses and color fading is obvious. The lower nitrite concentration gave the best color protection, probably because the higher concentration accelerated SH oxidation. The meat used in this work did not have any free nitrites present. It seems possible that different results would be found when using a nitrite positive product.

A comparison of Tables 1 and 2 shows that whereas light in the freezer has very little influence on the loss of sulfhydryl groups, it plays a very important role in color fading. Even in the presenec of SH groups nitrite gives only temporary color protection under continuous lighting of an intensity frequently observed in display counters and store aisles *(4)*. However, the amount of protection obtained might have considerable significance under commercial conditions where meats are not illuminated during the night. Color recovery of light faded meats has been shown to take place in the dark when the meats contain both nitrite and sulfhydryl *(7)*.

Since color fading is an oxidative process *(3, 5, 7)*, several workers proposed the use of airtight wraps as a means of color retention *(2, 4)*. In our third experiment we used Saran as an air impermeable wrap and polyethylene as an air permeable material for meats stored both in the dark and also under continuous illumination. Results show a slight advantage of Saran over polyethylene as a wrapping material. However, the difference between the visual scores is rather small. The effect of the wrapping material on the loss of SH groups was also slight and only noticeable in the untreated illuminated samples.

Results (Table 4) of a comparison of light fading in various commercial cured meats substantiate the hypothesis that lack of either nitrite or reducing groups will result in more rapid fading. The acceleration of color fading caused by nitrites in the absence of free SH groups is illustrated by the bologna 2 sample. On the other hand, in meat lacking nitrite, excess sulfhydryl has no protective effect.

In the course of our work numerous commercially cured meats were tested for free sulfhydryl groups. Only a few samples were found to be completely negative. It seems therefore feasible to protect cured meats to be displayed in lighted counters against color fading by a surface application of nitrite prior to packaging. The slight color fading occurring during the illumination could be counteracted by color regeneration during the night.

SUMMARY

The effect of temperature, light, wrapping materials and presence of nitrite on color fading and loss of SH groups has been determined. Loss of sulfhydryl groups was mostly affected by storage temperature: at room temperature the loss was considerably faster than at

TABLE 3
Effect of wrapping material on color loss and SH groups in Prem

NO_2 treatment	Light	Wrap	Color rating					Sulfhydryl			
			1 hour	6 hours	25 hours	42 hours	72 hours	6 hours	25 hours	48 hours	72 hours
None	40 f.c.	polyethylene	7	1	−2	−3	−6	+	+	±	−
	40 f.c.	Saran	7	3	−1	−2	−3	+	+	+	−
	None	polyethylene	10	10	8	5	4	+	+	+	±
	None	Saran	10	10	9	7	6		+	+	±
.2% NO_2 Dip	40 f.c.	polyethylene	9	5	2	1	−1	+	+	±	−
	40 f.c.	Saran	9	7	4	2	1	+	+	±	−
	None	polyethylene	10	10	10	10	9		+	±	±
	None	Saran	10	10	10	10	10		+	±	±

refrigerator and freezer temperatures in cured meats stored in the dark. Application of a 2% nitrite solution increased greatly the speed of sulfhydryl losses. Light and type of wrapping material showed little effect on SH losses.

Color fading was affected most markedly by light. Storage temperature was also of importance. Commercial meat products containing both free sulfhydryl groups and nitrite do not fade during lighting as fast as do samples lacking either one.

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Improvement of Food Flavor, Fat Stability, and Nutritional Value With Sesame Products[a]

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(Manuscript received August 28, 1956)

One of the more recent new agricultural products to appear on the American scene is sesame. Strangely enough, the seed of this plant is one of the oldest agricultural products harvested and used commercially by man *(1, 10)*. Archeological records show that the Sumerians, first occupants of Babylon, traded in sesame oil some 4,000 years ago.

Sesame is a plant grown in the warm areas of the world. In the Orient, the Near East, and in Africa sesame has been grown commercially for many centuries *(1, 8, 10)*. It also grows wild in parts of Africa *(11)*. It is said to have been brought to Central America by slaves in the eighteenth century *(9)*. There the seed has been harvested and exported to the United States. Principal uses in the United States are in baked products *(8, 9)* and in a special type of candy known as halvah. Sesame oil has been a world commodity for a long time and at times has been used in volume in the United States *(7)*. Because of its relatively high price it has not been used as extensively as the oil from soybeans, cottonseed, and the peanut.

After many years of plant breeding research by the U. S. Department of Agriculture, the corresponding department of the State of Texas, as well as by independent research groups, new varieties of the plant have been bred which lend themselves to the American climate and to agricultural harvesting machinery. The varieties commonly grown in Nicaragua are hand harvested. Careful handling is necessary since the pod opens upon ripening and the seed readily falls out.

The American varieties, in contrast are non-shattering—that is, the seed remains attached to the pod membranes. Other varieties have a closed pod upon maturity. Both types are now grown commonly in the Southwestern United States. Figure 1 shows sesame as it is grown in Texas.

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, June 12, 1956, St. Louis, Missouri.

Figure 1. Sesame plants at early growth stage.

The seed of sesame, obtained after threshing the pod, are rather small and elliptical in shape. They have a dark seed coat or hull. For baking purposes the hull is removed by a wet processing method. Figure 2 shows these two stages of sesame seed production.

COMPOSITION

Proximate analysis of natural sesame seed shows that it contains about 51% oil, 20% protein, and no starch *(10, 13)*. The dehulled seed is low in fiber. Table 1 shows a comparison of the composition of American sesame seed with Midwestern American soybean and with cottonseed.

Another interesting characteristic of the sesame seed is that it contains an unusual antioxidant system *(4, 10)*. The antioxidant present is sesamol, a phenolic compound. This is thought to be the active form. Present also is its precursor sesamoline, which is converted to sesamol by the action of strong mineral acids and also by hydrogenation of the oil. In general, the usual processing methods of pressure or solvent extrac-

TABLE 1
Proximate Analyses

	Sesame		Soybean	Cottonseed
	Natural	Dehulled	Natural	Natural
Moisture	5.8%	4.0%	11.0%	6-12.0%
Ash	5.7	3.0	5.0	3- 4.0
Protein	19.8	26.0	34.0	16-24.0
Carbohydrate	18.0	9-11.0	29.0	24-31.0
Oil	51.0	53-55.0	17.0	14-25.0
Crude Fiber	3.2	2.0	5.0	14-21.0

tion *(1)* do not remove all of the sesamol—sesamoline system with the oil. Apparently, it is tightly bound in the cellular structure or in some other component, and does not release very easily (see Table 2). The common method of obtaining sesame oil has been by hydraulic pressing of the raw natural seed. This raw oil is then alkali refined; some is even used after simple filtering only.

USES OF SESAME

Aside from the oil, the chief use for sesame is in the baking industry, where it is valued for its particular flavor. The seeds have been commonly used to decorate and flavor the top crust of bread and rolls *(8, 9)*. The flavor is developed through the roasting action in the oven. Raw-dehulled seeds do not possess a very attractive flavor. Obviously the raw-dehulled seeds cannot be mixed in the dough because the insulating effect of the dough would prevent proper heat treatment and result in a raw "beany" flavored bread. Even simple pre-roasted and dehulled seed does not give a good flavor to bread, since it fails to release much of the inherent flavor value of the sesame. Grinding the raw dehulled seed is virtually impossible, because its high oil content lubricates the cellular structure to prevent shattering.

PROCESSING OF DEHULLED SESAME

By using a process which is a combination of steam and dry heat, along with impregnation with sodium chloride and/or sucrose and other crystalline materials it is possible to change the sesame seed *in situ*. Thereby, the cellular structure is altered and the delicate flavor characteristics are accentuated and released from the bound state. Furthermore, the *in situ* process alters the cellular structure so that satisfactory grinding is possible. The ground product is a paste. This form is taken by reason of the high oil content and low moisture (1%) level. The oil tends to separate from the protein portions of the paste unless stabilized with emulsifiers.

This ground or homogenized sesame seed when used at a low percentage level is valuable for accentuating other natural food flavors, and at higher levels for producing sesame flavor in baked and other manufactured food products.

The whole dehulled seed, after the impregnation and roasting process, retains its original shape. It is easily crushed or flaked, similar to whole wheat. These different forms are shown in Figure 2 which presents (1) the whole processed seed, (2) flaked processed seed, and (3) the homogenized product.

PROCESSED SESAME IN BAKED FOODS

These processed sesame products are not only different in shape of particle size but also are different in flavor intensity. The processed whole sesame and the flaked product may be used in bread formulas at levels many times that of the homogenized product. The latter has much greater flavor accentuating power than the other two and, besides this, the shortening value of the oil becomes a recognizable factor. In the whole seed the oil is still bound tightly to the cellular material with the individual seed shape retained and therefore has no shortening effect.

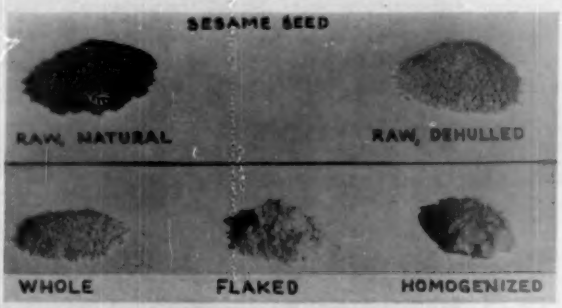

Figure 2. Processed sesame.

The processed whole and flaked sesame products accommodate themselves well to typical formulas for white bread sponge and dough processes. Amounts up to 20%, based on wheat flour weight may be used directly in the dough stage without reducing loaf volume. Even crumb color is not seriously darkened as might be expected. The grain is more open than the control; the texture, however, is softer than the control and retains the softness advantage over a 5-day storage period. By adjusting the relative amounts of processed whole and flaked products, greater sesame flavor is obtained.

The homogenized sesame also adapts well to an ordinary white sponge and dough process. However, about 4% appears to be a maximum due to the action of the oil which has been released by the grinding. At this level, flavor of the bread is markedly changed. Figure 3 shows loaves of bread baked with sesame.

Nutritionally, sesame offers much in the way of possible increase in protein content of bread. If 20% of the whole and/or flaked product is used, the protein level is increased substantially. The protein content of the sesame bread in Figure 3 is 9.8% calculated on a 38% moisture basis in contrast to the standard white bread at 8.5%. Sesame protein contains 3% of the essential amino acid methionine and 2.7% lysine *(3)*. The quality as well as the quantity of protein in the bread would be improved by the addition of sesame.

Figure 3. Comparative appearance of bread. Left, a standard white bread. Right, with addition of 20% processed whole and flaked sesame.

Up to the present, sesame meal has never been produced commercially for edible purposes. This is strange, since some of the Central American countries which have a protein-deficient diet are also producers of sesame. The extraction of sesame oil in those countries is from raw, natural seed, which produces a meal severely lacking in flavor, high in fiber, and resistant to grinding. It is therefore useless as a human food product.

The American sesame process, in contrast, yields a seed which when ready for oil extraction has been dehulled and is therefore of low fiber content. Flavor has been accentuated; the meal from even an hydraulic pressing operation is flavorful. Solvent oil extraction methods on the processed seed yield a meal containing about 1% oil and 55% protein. Sesame meal of this variety has a high nutritional value, and its use in baked products, whether they be white bread served to North Americans, or tortillas served to Central and South Americans, will go far toward raising the dietary value of their carbohydrate foods.

ANTIOXIDANT VALUE OF SESAME OIL AND HOMOGENIZED SESAME

There are many references to the long storage life of sesame oil *(2, 3, 5)*. Much research has been done to show that the sesamol-sesamoline complex is responsible *(10)*. Budkowski *(4)* has shown that synthetic sesamol when added in sufficient amounts to other vegetable oils increases the number of hours the oil will last when tested according to the standard Active Oxygen Method *(6)*. Our experiments have indicated that a good sesame oil when added to other vegetable oils such as cottonseed, soya, or corn oil does not significantly increase the keeping time as shown by the Active Oxygen Method and by storage tests at different temperatures.

Comparison of results obtained by testing sesame oil by the standard Active Oxygen Method shows interesting differences. Table 2 gives the values.

Since the data in Table 2 show antioxidant values in the processed homogenized sesame products far higher than ever attained in the extracted oil, according to the usual methods, a series of experiments was made on pie crust to determine whether this antioxidant effect can be brought into play on lard. Some commercial antioxidants have a fair carry-through value, but others are almost completely destroyed by high oven heat.

TABLE 2
Comparative values of processed sesame, cottonseed and soybean oils

	A.O.M. hours
Refined soybean oil (commercial)	18
Refined cottonseed oil (commercial)	19
Refined sesame oil (commercial)	21
Oil pressed from raw natural sesame seed	27
Oil pressed from dehulled processed sesame	36
Homogenized processed sesame	83
Oil extracted by solvent from homogenized processed sesame	72

In this series of tests, pie crusts were prepared and baked according to the formula shown in Table 3.

The pie crusts were crushed and the fat extracted with chloroform. After careful separation from the solvent, the oils were tested by the Active Oxygen Method. The results are shown in Table 4.

It is apparent that the oils extracted from pie crusts which had been made with added homogenized sesame have A.O.M. values significantly higher than the controls without added homogenized sesame. This "carry-through" effect is of importance. The crusts containing the homogenized sesame had a deeper brown crust color, increased tenderness, and better flavor.

TABLE 3
Pie crust formula

	Grams
Flour	500
Lard	300
Salt	15
Water	100

Crusts baked at 425° F. for 22 minutes

TABLE 4
Effect of homogenized processed sesame on pie crust

	A.O.M. value of extracted oil		
	Commercial lard no. 1[1]	Comnsercial lard no. 2[1]	Prime steam lard[2]
Control—no sesame	26 hrs.	1.5 hrs.	4 hrs
4% homogenized processed sesame[3]	34	3	5.5
8% homogenized processed sesame	38	4	7.5

[1] Label indicates presence of added chemical antioxidants.
[2] Before addition of chemical antioxidants.
[3] Based on weight of lard in formula.

One conclusion to be drawn from the data in Tables 2 and 4 is that the antioxidant system of sesame is not readily released, since much more apparently is present in the whole seed than is present in the oil obtained by pressing either natural or raw dehulled seed. Commercial refining of such oil further destroys some of these antioxidants *(10)*.

The high A.O.M. value of the homogenized sesame and its availability for action on the inherent sesame oil are apparent. This indicates that the processing either releases more of the antioxidant or alters its structure to make it more effective. The action on lard in pie crusts shows its "carry-through" effect, an effect which is probably of commercial value. Other food products containing animal fats offer possibilities for the application of homogenized sesame.

SUMMARY

Sesame is an oil-bearing seed—ranking as one of the highest in oil content as well as in length of time of cultivation by man. Sesame possesses unique characteristics such as being starch-free and high in protein value. Present in the seed are antioxidant compounds, sesamoline and sesamol, responsible for the exceptional keeping properties of the oil. Sesame has been known and utilized for its flavor value but only on the surface of bread and rolls. Much of the flavor value and oil-antioxidant potentialities of sesame have gone unrealized because of the rather sturdy structural nature of the seed, which effectively binds these properties inside the seed envelope. Dehulling or removal of the seed coat followed by the heat processing yields a new type of sesame product.

Grinding this heat-processed seed releases the oil and yields a flavor-rich product. Antioxidant value is high.

Several food products besides bread and other baked articles present possible opportunities for application of the flavor and other properties of heat-treated sesame.

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Quality Control Program for the Processing of Sweet Corn[a, b]

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(Manuscript received June 13, 1956)

The history of the application of modern quality control to industry is only about twenty-five years old. Shewhart, who originated the control chart, reported on his theories in 1931 *(18)*. However, statistical quality control (henceforth, SQC) has not gained a foothold as rapidly in food processing as in some other industries *(19)*. The literature of SQC as it pertains to the food industry is limited. Some authors *(3, 6, 8)* have presented a case for its use in a general way with few specific examples; others *(2, 6, 7, 12, 13)* have discussed and explained the underlying theories of probability and/or suggested simplified procedures of calculation and application. The most successful utilizations of the control chart procedure appear to be in the area of weight control *(2, 4, 7, 16, 17, 19)*.

Research at the University of Maryland and other institutions, reviewed in 1954 *(9)*, provided a number of tools with which quality factors in sweet corn might be readily evaluated objectively. Thus, the usefulness of developing a comprehensive program for the application of this knowledge to actual production problems seemed evident. Cream style and whole kernel packs were represented in the studies, since there are quality problems common to both styles.

MATERIALS AND METHODS

During the corn harvesting season of 1953, a cream style corn packing plant on the Eastern Shore of Maryland was selected for study. Chief varieties packed during the study were Aristogold Bantam Evergreen, some Iochief, and some Huron.

Control stations were established at the receiving, in-plant, and finished product (at the filler) points of production. Hourly samplings and quality determinations were made and recorded at each of these 3 points. At the receiving station 25 ears of corn were selected at random from the incoming trucks. The sample was weighed, husked, and the husked ears reweighed. The number damaged by insect infestation was next determined. Simulating the practice of the plant, the damaged portions were then trimmed off with knives. Trimmed weight was recorded and the kernels were cut from the cob in a commercial cutter provided by the plant management. Cob weight was recorded and the cut kernels, collected in a pan and thoroughly mixed, were evaluated for succulence *(15)*, kernel diameter *(10)*, and pericarp content *(14)*. From the determinations at the receiving point the following calculations were made: percent (by count) ears insect infested, percent (by weight) trimming loss, percent (by weight) cut-off, and a trimetric maturity index according to the procedure of Kramer *(11)*. These calculated values along with the succulometer determinations were plotted on SQC charts *(5)*. The first week's data were used to determine the process variability required for calculating the limits of all control charts.

At the in-plant station 25 ears of corn were selected at random from the production line after the husking and trimming operations had been completed. The number that still showed damage due to insect infestation was recorded. The kernels were cut from the cob and succulence, kernel diameter, and pericarp were determined by the previously cited methods. From these determinations, the percent ears insect infested and the trimetric maturity score were calculated. These values together with succulometer values were plotted on control charts.

Three quarts of cream style corn were removed from the filling machine to determine the quality at the finished product station. One quart was utilized in an insect fragment count by the gasoline flotation technique, in which the sample is mixed with a half pint of lead-free gasoline and the number of insect fragments that float to the surface are counted with the aid of a magnifying glass. With the remaining quarts of corn, consistency and defects were determined and canned samples were

[a] Scientific Publication No. A564, Contribution No. 2271 of the Maryland Agricultural Experiment Station (Department of Horticulture). Partial support from funds provided under the Research and Marketing Act of 1946, Project NEM3.

[b] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 13, 1956.

prepared. Consistency was determined with the Adams consistometer *(1)* and defects were determined, after the consistency test, according to a scale devised from a somewhat arbitrary interpretation of the Agricultural Marketing Service's grade sheet for cream style corn *(22)*. Each discolored or pulled kernel, piece of cob or husk was counted as one defect. One defect point was allowed for every 10 inches of silk. Consistency, insect fragments, and defects were posted on control charts at the finished product control station.

Preserved samples were opened for analysis after one day, six months, and one year of storage. Consistency was determined with the Adams consistometer.

For the 1954 season, a plant packing whole kernel corn at another location (in Maryland) was selected for study. Shoepeg was the principal variety packed during this study. Hourly samplings and quality determinations were made at the receiving and at the filler or finished product control station.

Procedures were similar to those used for the cream-style study except that fill and drained weight measurements were made instead of consistency.

Five to 6 months after the canned samples had been prepared, they were opened and the drained weight was determined *(21)*.

RESULTS AND RECOMMENDATIONS

The most commonly used quality control charts are mean ($\bar{x}$) charts, which indicate the average quality level, and range (R) charts, which show the range in values obtained for any group of samples whose average is plotted on the $\bar{x}$ chart. The number of samples included for each point charted varies from 1 upward, depending on the circumstances, and is commonly 5. Thus, it is rather usual to obtain 5 separate determinations for the quality factor to be charted, record the mean for these 5 values on the $\bar{x}$ chart, and the difference between the highest and lowest values within the group of five on the R chart.

However, the procedures used for the quality evaluation of sweet corn are time consuming, so that approximately one hour is required to obtain only a single determination for each of the factors shown in Figure 1. It was therefore recommended that with few exceptions each of the values posted on these $\bar{x}$ charts should represent a single determination, which automatically precludes the use of a range chart. The weekly summary, however, may include both charts, with the $\bar{x}$ values consisting of the daily, or shift average, and the range chart values consisting of the difference between the higest and lowest values obtained during the day or shift.

Based on the needs of the plants studied and the results obtained at these plants with SQC techniques, the following control program is recommended.

Receiving control station. Figure 1 is a suggested data sheet which may be used at the receiving control station for collecting data and plotting SQC charts. In this sheet, provision is made for the collection of data required for the calculation of the percentage of ears insect infested *(No. insect infested ears/no. raw ears x 100)*, percent trimming loss *(lbs. trimmed ears/lbs. husked ears x 100)*, percent cut-off *(lbs. cut-off/lbs. raw ears x 100)*, and trimetric maturity—namely, kernel size, percent pericarp, and succulometer interpreted with aid of suitable nomograph *(11)*. Results from the studies reported in this manuscript would indicate that establishment of the above 4 factors on SQC charts should prove beneficial.

It is suggested that data be collected for at least one week before control limits are calculated for any of the control charts. After two or more weeks' data have been compiled, it might prove advantageous to recalculate and adjust the control limits. The calculations need not prove time consuming nor cumbersome since there

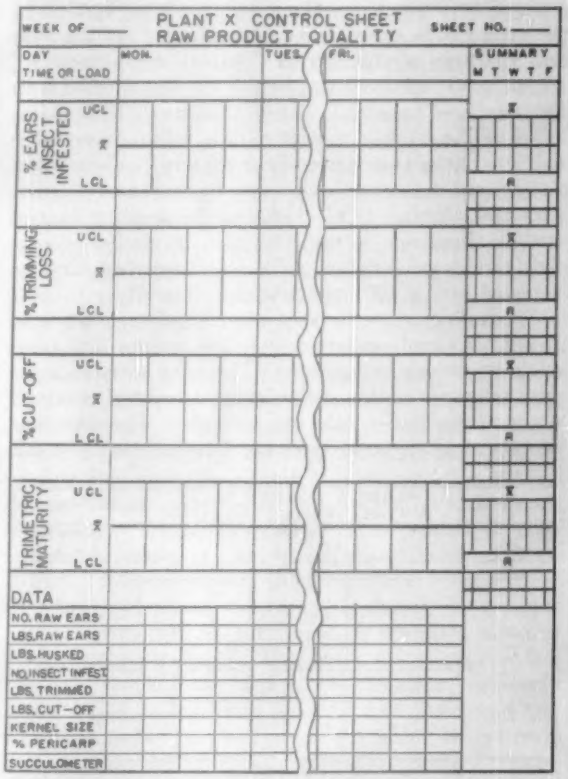

Figure 1. Suggested quality control chart for use at the raw product receiving station of whole kernel or cream style sweet corn processing plants.

are available rapid, simplified procedures for estimating the standard deviation from the range when normal distributions of the population are expected *(12)*. The control limits thus established will give an estimate of the inherent variability of the process. It will then be up to the individual processor to decide whether these are in line with what is wanted, whether the variability can and should be reduced, and/or whether, allowing for the same degree of variation, the mean of the process can and should be shifted upward or downward.

The data sheet in Figure 1 should prove suitable for cream style or whole kernel corn manufacture. If factors such as insect infestation and trimming loss are of no significance at a particular plant, they should be dropped from the program.

Twenty-five ears of corn, randomly collected from a truckload or conveyer belt as the particular situation might demand, is in most cases an adequate hourly sample. After the determinations have been completed, most of the raw corn can be recovered and returned to the processing line; thus, little loss of material should be incurred in following the above plan.

Placing the factors above indicated on SQC charts will enable the processor to make intelligent, on-the-spot decisions with regard to raw product quality at any time.

In-plant control station. Control charts at this point were not deemed necessary during the whole kernel study; damage to the raw product and consequently losses due to trimming were found to be negligible. In the cream style study, however, such was not the case and charting of the factors "percent ears insect infested," and "trimetric maturity," was found to be both necessary and beneficial. If SQC charts are to be maintained at the in-plant control station, it is recommended that the above two factors be considered. Figure 2 is a suggested data sheet which may be used for collecting data and plotting SQC charts at the in-plant control station. Provision is made for the calculation of percent ears insect infested *(No. insect infested ears/no. trimmed ears x 100)* and trimetric maturity.

For testing at the in-plant control point, a sample of 25 ears randomly collected after the husking and trimming operations is suggested. The same remarks made with reference to the establishment of control charts at the receiving station hold true here also. The individual processor will have to make the decisions that best suit

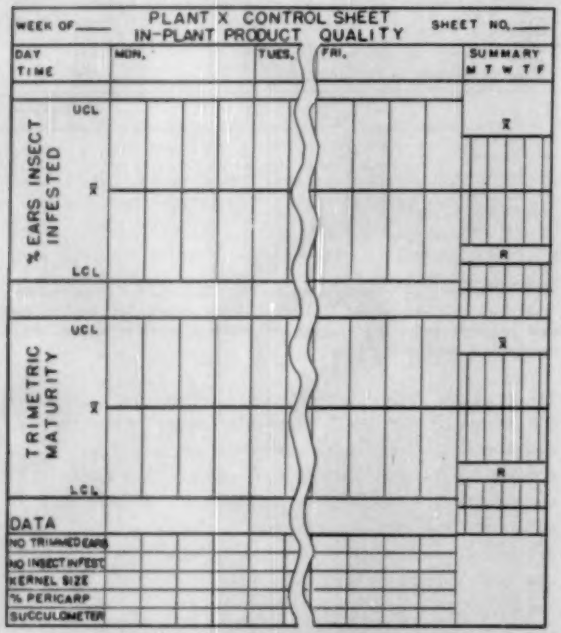

Figure 2. Suggested quality control chart for use at the in-plant station of cream style sweet corn processing plants.

his needs. The benefits that might be expected from maintaining SQC charts at this control point are the checks afforded on the trimming and sorting operations and the effect of these on the maturity level.

Finished product control station. The factors that should be considered at the finished product control station, if whole kernel corn is being packed, are drained weight, absence of defects, and maturity. Control of these factors would seem to be a minimum requirement if a uniform and profitable operation is to be insured. Figure 3, a suggested data sheet, may be used for collection, summation, and plotting of the data at this control station.

It is recommended that at least 4 to 5 successive units be taken at the filling machine as an hourly sample and that drained weight and defect counts be determined

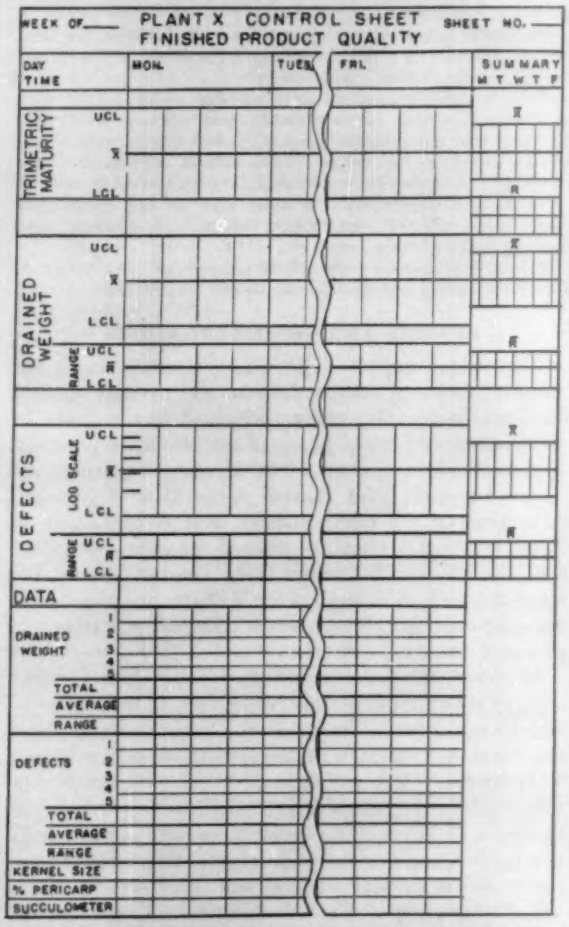

Figure 3. Suggested quality control chart for use at the filler station of whole kernel sweet corn processing plants.

for each. The average value for the respective factors is then found and posted on the control charts. The limits for control charts in which averages are to be plotted must be adjusted to account for this fact by dividing the 3-sigma value by the square root of the number of units being averaged. Range charts for the hourly data would seem advisable for the drained weight and defects factors since such data may be readily obtained where several units are being sampled at one time. Limits for this type of chart are easily established *(5)* and plotting of the range values will provide a measure of the uniformity of the process.

In establishing the mean and control limits for drained weight at the filler, the tendency of sweet corn kernels to increase in drained weight after the addition of liquor to the can should be considered. The relation of maturity of the corn to the percent increase in drained weight over fill in weight is shown in Figure 4. Thus,

sweet corn of fancy quality, having a grade of 39, let us say, in accordance with the U. S. grading system, may be expected to have a drained weight of the canned product of approximately 4% higher than its weight at the filler. On the other hand, standard corn, having a

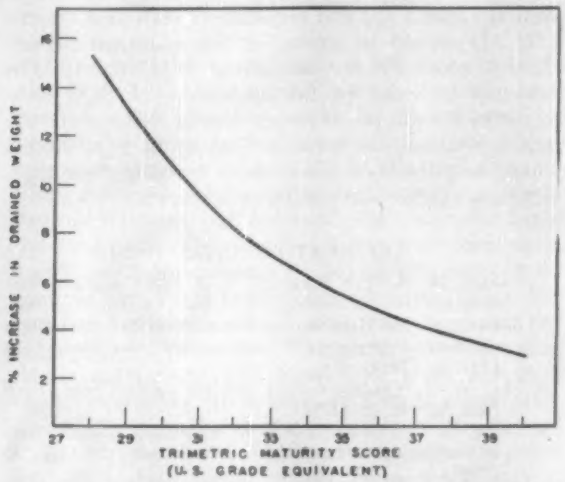

Figure 4. Increases in drained weight over fill-in weight after processing and storage as predicted from trimetric maturity scores for whole kernel sweet corn.

U. S. grade score of 28, may be expected to increase by as much as 15% in drained weight following the addition of liquor and a minimal period of storage.

Since skewed distributions are to be expected with defects data, semi-logarithmic paper as indicated in Figure 3 should be used to establish control limits for this factor. Figure 5 illustrates the normalization of defects data by the use of logarithmic transformation.

The scale set up for making defect counts during the course of the whole kernel study was found to be quite adequate and its use will provide a satisfactory index of the defects level. This scale allows one point for every piece of cob, husk and discolored kernel; one point for every 10 pulled kernels; and one point for every 10 inches of silk.

After the drained weight and defects determinations have been completed, it is suggested that the contents of the 4 or 5 units be thoroughly mixed and that a representative sample be taken for the trimetric maturity evaluation. The remaining corn can then be recovered and returned to the processing line.

A data sheet to be used with cream style corn at the finished product point is presented in Figure 6. Consistency, insect fragments, and absence of defects are the major factors to be considered at the filling machine when cream style corn is being manufactured. Since cream style corn is not produced by a continuous process, but is prepared in discrete batches, each batch may be considered comparatively homogeneous. A process that involves repetitive batches that are within themselves homogeneous lends itself to single sampling. Thus single hourly samples *(one sample/batch)* should prove adequate at this control point. Sufficient material should be obtained for the required determinations. It is suggested that the Adams consistometer be utilized or one similar in design be constructed for determinations of the consistency factor. The relation of consistometer values at the filler (temperatures of 170-190° F.) to consistometer values of the canned product after different periods of storage is shown in Figure 7. Defect counts may be performed on the same material used for the consistency test, since the volume of the cone provided with the Adams consistometer is approximately equal to that of a No. 303 can. The scale for counting defects provided above for whole kernel corn may also be used with the cream style product. Since

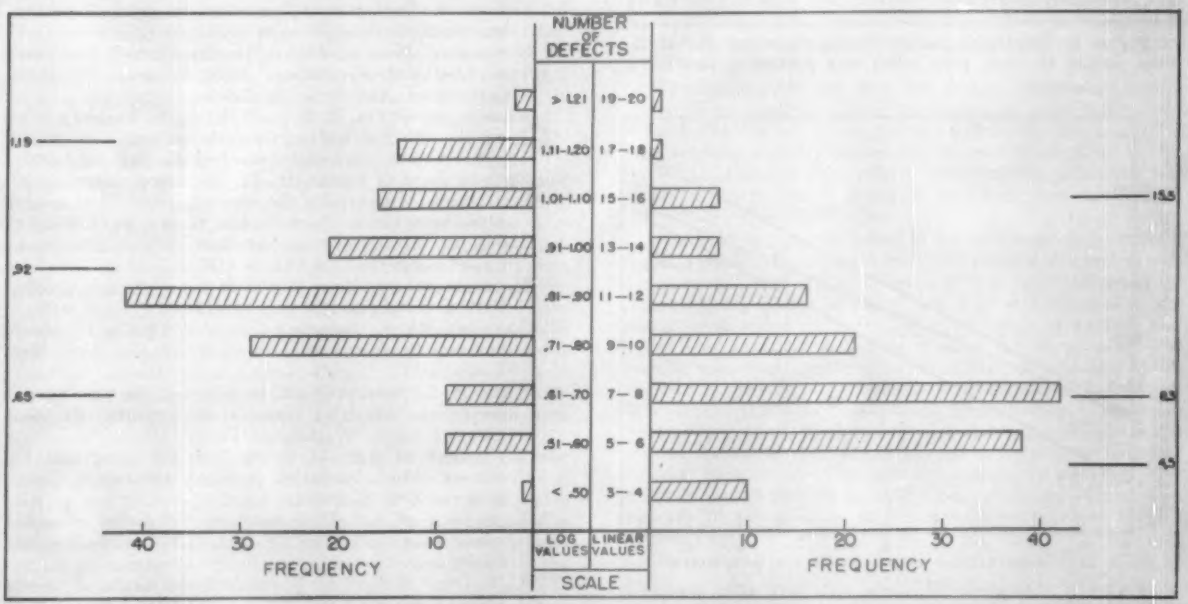

Figure 5. Frequency histograms of defect counts of 143 samples of cream style corn showing a skewed distribution (right) when actual defect counts are used, and the normalization of the distribution when using a logarithmic transformation (left).

a skewed distribution with the defects factor should also be expected here, the same suggestions made for normalizing this distribution for whole kernel corn should be considered.

The gasoline flotation test outlined in the materials and methods section is recommended for rapid detection of insect fragments. Specification limits will have to be established for this factor when insect infestation becomes a serious problem. Insect fragments, of course, must be entirely eliminated from the product, if humanly possible.

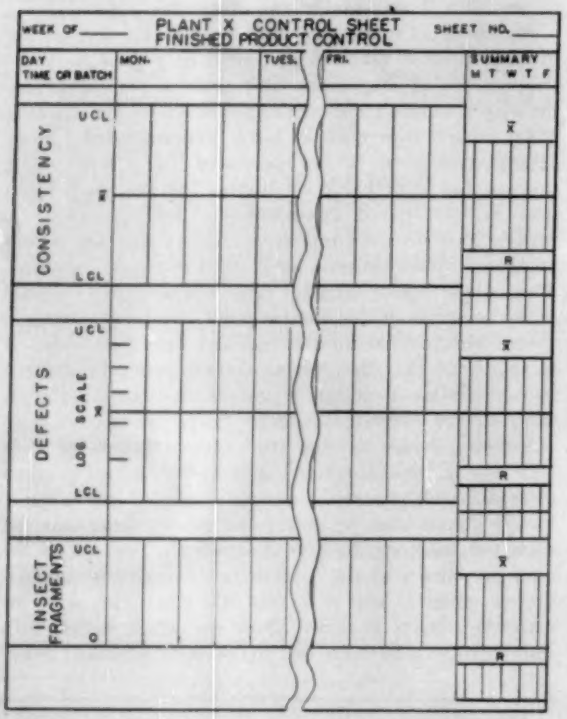

Figure 6. Suggested quality control chart for use at the filler station of cream style sweet corn processing plants.

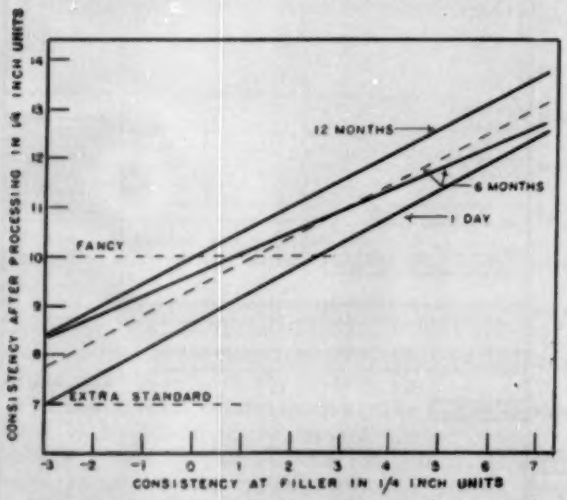

Figure 7. Consistency of cream style corn after processing and storage as predicted from consistency at the filler (as determined with the Adams consistometer).

A FINAL WORD

Based on the results of the studies reported in this manuscript, a brief summary of the factors to be considered and the general plan that may be followed in setting an SQC program into operation in sweet corn canning plants has been presented. Reference to texts such as Grant's *(5)* and publications such as Kramer's *(12, 13)* should be made for the mathematical mechanics necessary for calculating SQC limits. The examples provided by the application of SQC techniques to the two plants reported on in this text and the quality relationships developed during the SQC studies should help the corn processor in applying these SQC techniques to his own particular operation.

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Effect of Gamma Irradiation on Cake Mixes at High and Low Moisture Levels[a, b]

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(Manuscript received August 3, 1956)

THE ABILITY OF GAMMA RAYS to kill microorganisms without the use of heat suggests a means by which heat-sensitive cereal products might be "pasteurized" or sterilized in order to increase their shelf life. Very little information is available in the literature as to the effects of various levels of irradiation on cereal products. Brownell, Harlan and Nehemias *(1)* irradiated bread and cake flour. They concluded that treatments up to 2×10^4 rep did not change the baking properties of the flours. Cakes made from flours receiving higher dosages had low total volumes, were heavy, compact and had a yellow crumb color. Flavor changes were noticeable in cakes made with bread flour given a dose of 1×10^5 rep. Other literature pertaining to cereal products *(3, 5)* showed that a gamma irradiation dose of 2.5×10^4 rep will control insect infestation in cereal products without change in their properties.

In view of the small amount of information available, it was considered desirable to determine gross effects of irradiation on cereal products. Since the presence of high moisture might increase the effects of irradiation thus making them more noticeable and more easily detected, it was decided to have a batter irradiated as well as dry mixes.

EXPERIMENTAL

The first experiment carried out was with white cake batter. The batter was placed in sealed No. 2 (307 x 409) tin cans and shipped to the Materials Testing Reactor at Idaho Falls, Idaho. Irradiation dosages of 1×10^4, 3×10^4, 1×10^5, 7×10^5, and 2×10^6 rep were used. The dosage rate at the reactor was measured daily, and the dosage the products received was calculated from the exposure time. The canned batter was maintained at approximately 40° F. (4° C.) during shipment to and from the irradiation source by use of insulated containers containing dry ice. The irradiation of the samples was carried out at a temperature of 67.5° F. (19.7° C.). The dosage rates used for irradiation were 4.07×10^5 and 4.26×10^6 rep per hour. The minimum exposure time was one minute and 30 seconds; the longest was 28 minutes. Approximately 72 hours elapsed from the time the shipment was sent until receipt of the irradiated batters. Cans of batter were included in the shipment that were not irradiated. This was done to determine the effect of shipment on the batters. Upon receipt, the irradiated batters were placed in storage at 45° F. (7° C.) and at room temperature.

The second experiment dealt with dry white and spice cake mixes. The dry mixes were packaged in cardboard containers with glassine liners. These products were irradiated at Argonne National Laboratories at Lemont, Illinois. The mixes were subjected to irradiation dosages of 5×10^4, 1×10^5, 5×10^5, and 1×10^6 rep. The dosage rates to which the mixes were exposed were determined by ferrous dosimetry and ranged from 0.490×10^4 rep per minute to 3.47×10^4 rep per minute. The time of exposure of the samples ranged from 5.81 minutes to 95.24 minutes. The samples were shipped under ambient conditions and approximately one week elapsed from the time of shipment until receipt of the irradiated mixes. Packages of dry mix were included in the shipment as controls to determine the effects of shipment on the mixes. The irradiated and control samples upon receipt were placed in storage at 100° F. (38° C.) and —10° F. (—23° C.).

Total sugar and reducing sugar contents were determined by standard AACC methods *(2)*.

Procedure used for batter moisture was AOAC Method 22.4 *(8)*. Procedure for dry mixes was the AOAC Method 13.4 *(8)* with the exception that the oven temperature used was 105° C. for 2 hours.

The pH was determined by AOAC Method 13.27 *(8)*.

Fat was determined by extracting 25 g. of dry mix with ethyl ether in a Soxhlet Extractor for 16 hours. The ether was evaporated on a steam bath, the residue weighed and reported as fat. Twenty-five grams of batter was mixed with diatomaceous earth and then dried to less than 10% moisture at 105° C. This material was extracted with ethyl ether and the procedure as reported for dry mixes followed.

Fatty acidity was determined on the extracted fat using AOAC Method 13.61 *(8)* with the exception that 95% ethyl alcohol was used for the extraction instead of the benzene alcohol mixture.

Monoglycerides were determined using the method of Pohle and Mehlenbacher *(9)*.

Iodine value of the extracted fat was determined by the Wijs method *(7)*.

Batter viscosity was determined by means of a Brookfield Viscosimeter. The instrument was operated at a speed of 6 r.p.m. using spindle number 4.

Determination of total bacteria was made on plate count agar (Difco). The plates were incubated at 30° C. and counted at 24 and 48 hours. Standard bacteriological methods and equipment were used *(10)*.

The Amylograph test was run using a Brabender Amylograph. One hundred twenty-five grams of cake batter were diluted with 250 ml. of Amylograph buffer *(6)*. The gelatinization viscosity was determined over a temperature range of 30° to 90° C. For dry cake mixes, the preceding procedure was followed except that 70 grams of cake mix were diluted with 305 ml. of Amylograph buffer.

Alpha amylase was estimated in the cake batter by a reducing sugar method *(11)* using an excess of gelatinized wheat starch. One part of batter was combined with 5 parts of buffer pH 4.7 (MacIlvaine's Buffer Mixture) and 4 g. of gelatinized wheat starch were added for every 100 g. of batter used. This material was mixed in a Waring blender for 30 seconds. The sample was then incubated at 30° C. for 30 minutes. After incubation, the slurry was centrifuged 10 minutes at 2,000 r.p.m. The supernatant was then filtered through No. 4 Whatman paper. To a 46 ml. aliquot of filtered supernatant, 2 ml. of 3.58 normal sulphuric acid and 2 ml. of 12% sodium tungstate solution were added. This mixture was shaken and then centrifuged for 10 minutes at 1500 r.p.m. Reducing sugars were run on 10 ml. aliquots of the supernatant by the Schoorl method *(4)*.

For dry cake mix, 23 g. of cake mix were added to 92 ml. of buffer pH 4.7 (MacIlvaine's Buffer Mixture) and 1.6 g. of gelatinized starch were added. The above procedure was then followed.

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[a] This paper reports research undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 645 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or endorsement of the Department of Defense.

[b] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 13, 1956.

RESULTS AND DISCUSSION

White cake batter. Immediately after receipt of the irradiated batters, chemical analyses were made. No apparent differences between the treated and untreated samples were found in total sugar, reducing sugar, fat, iodine value of the extracted fat, monoglycerides, acidity or pH. The data are shown in Table 1. Since no changes were detected, only the highest level of irradiation was used for illustration in this Table.

Viscosities were determined using a Brookfield Viscosimeter. The data shown in Table 2 indicate that there is no significant change in viscosity at 7×10^5 rep or below. At 2×10^6 rep, the viscosity was approximately double that of the other batters.

The data in Table 3 show that irradiation dosages of 1×10^4 and 3×10^4 rep caused no apparent changes in characteristics or baking performance prior to storage. However, when the dosage was increased to 1×10^5 rep or above, the batters did not produce acceptable cakes prior to storage. A wet chicken feather odor was detectable in these samples.

The effect of storage on the irradiated batters is shown in Tables 4 and 5. The data in Table 4 show that after 2 weeks' storage at room temperature neither the treated nor the untreated batter produced acceptable cakes. The cakes were heavy and compact and all were low in volume. Table 5 shows the effect of 3 weeks' storage of the batter at 40° F. (4° C.). Although the cake volumes were good with the exception of the 1×10^5 rep sample, the cakes had a very compact grain and were somewhat dark in color. These cakes were not considered satisfactory.

The initial bacteriological results shown in Table 6 would indicate that there was no appreciable decrease in numbers of bacteria below a dosage of 1×10^5 rep. This indicates that, to obtain a desirable reduction in numbers of bacteria, cake baking characteristics of the batter would be destroyed. The data also show that after 2 weeks of storage at room temperature, there is a tremendous increase of bacteria. The batter stored at 40° F. (4° C). showed essentially no change in numbers of bacteria after 3 weeks.

Alpha amylase activity was used as an index for the effect of the irradiation treatment on the flour enzymes. The values obtained for the initial alpha amylase activity indicated that, even at the maximum dosage, there was no significant decrease in enzyme activity.

TABLE 1

A comparison of analytical values for treated and untreated samples of white cake batter, white cake dry mix and spice cake dry mix

Analysis (%)	White cake batter		Spice cake mix		White cake mix	
	Control	2×10^6 rep	Control	1×10^6 rep	Control	1×10^6 rep
Moisture	37.90	—	3.88	4.02	3.75	3.74
Total Sugar	26.39	25.70	44.17	45.66	46.01	47.75
Reducing Sugar	1.45	1.50	none	none	none	none
Fat	8.07	7.71	9.50	9.62	9.90	9.85
Iodine Value (of extracted fat)	57.4	56.3	62.6	62.7	54.6	54.1
Monoglyceride	0.23	0.15	1.02	1.03	0.53	0.58
pH	7.20	7.25	6.75	6.80	6.45	6.40

TABLE 2

Effect of irradiation on the viscosity of white cake batter (Brookfield viscosimeter at 23° C.)

Treatment (rep)	Average Viscosity (CPS)
Control	37,000
1×10^4	35,700
3×10^4	35,200
1×10^5	30,700
7×10^5	36,200
2×10^6	65,200

TABLE 3

Initial observations on baking performance and batter characteristics of irradiated white cake batters

Treatment (rep)	Batter observations	Grain and texture of baked cake	Volume (cc.)
Control	Good, no off odor	Good	1040
1×10^4	Good, no off odor	Good	1050
3×10^4	Good, no off odor	Good	1040
1×10^5	Slight separation, no definite off odor	Slight discoloration, coarse, bready and gummy	920
7×10^5	Separated, "chicken feather" odor	Very poor, gelatinous and brown	850
2×10^6	Separated, batter broken down, "chicken feather" odor	Very poor, gelatinous and brown	650

TABLE 4

Baking performance and batter characteristics of irradiated white cake batter after two weeks' storage at room temperature

Treatment (rep)	Batter observations	Grain and texture of baked cake	Volume (cc.)
Control	Slight separation, slightly curdled, no off odor	Heavy, compact, soggy	970
1×10^4	Slight separation, slight off odor of stale fat	Compact, soggy	990
3×10^4	Slight off color (tan), slight separation, odor of stale fat	Compact, soggy	930
1×10^5	Broken down, brown color, odor of stale fat	Heavy, soggy, colored	890
7×10^5	Broken down, brown color, "chicken feather" odor	Flat, soggy, dark brown color	810
2×10^6	Broken down, brown color, strong "chicken feather" odor	Flat, soggy, dark brown color	610

TABLE 5

Baking performance and batter characteristics of irradiated white cake batter after three weeks' storage at 40° F. (10° C.)

Treatment (rep)	Batter observations	Grain and texture of baked cake	Volume (cc.)
Control	Separated, slightly curdled, no off odor, slight off color	Slightly bready, compact	1060
1×10^4	Separated, no off odor, slight off color	Slightly bready, compact	1015
3×10^4	Broken down, "chicken feather" odor, dark color	Compact, gummy, brown color	975
1×10^5	Broken down, strong "chicken feather" odor, brown color	Compact, gummy, brown color	870

These data support the claim that gamma irradiation at low levels has little or no effect on enzymes.

The Amylograph was used to determine the effect of gamma irradiation on the heat gelatinization properties of the wheat starch. Table 7 shows the rapid decline of the Amylograph viscosity as the number of reps increased. The nature of this change in the starch has not been determined but the data indicate that the irradiation treatment is causing the starch to lose its gelling properties.

Dry cake mixes. The spice and white cake dry mixes were examined upon receipt after irradiation. The initial chemical analyses showed no significant change in total sugar, reducing sugar, fat, iodine value of the extracted fat, monoglycerides, fat acidity or pH of the dry mix (Table 1). Table 8 shows the observations of the initial baking performance and batter characteristics. The results indicated that the irradiation of white cake mix with 5 x 10^4 rep caused no significant change. Dosages of 1 x 10^5 rep or more resulted in cakes having a compact structure, low volumes, and dark colored crumb. The cake observations are in good agreement with the dry mix observations. At levels of irradiation higher than 5 x 10^4 rep, off odors and darkening were apparent in the dry mixes. Initial observations on the spice cake mix were very similar to those on white. The one significant difference between the two was the dosage required to produce deleterious effects in the baked cakes. The spice cake mix withstood the 1 x 10^5 rep treatment with no signs of deterioration. There was only a slight reduction in quality at the 5 x 10^5 rep level. The reason for the increased resistance of the spice cake mix is not known.

The initial bacteriological results on the white and spice cake mixes are shown in Table 9. These results show that, in a dry mix, the number of bacteria can be significantly reduced before the baking characteristics of the cake mix are destroyed.

Alpha amylase was again used as an index for the effect of the irradiation on the flour enzymes. The results on the dry cake mixes are the same as those of the treated batters. The maximum level of irradiation (1 x 10^6 rep) caused no reduction in alpha amylase activity.

The effect of the irradiation treatment on the gelling properties of the wheat starch is shown in Table 10. It can be readily seen that as the dosage increases, the ability of the starch to form a gel decreases. The reason for the change in gelatinizing properties is not known.

TABLE 6

Bacteriological counts of irradiated white cake batter (bacteria per gram)

Treatment (rep)	Initial	Room temperature (two weeks)	40° F. (10° C.) (three weeks)
Control	610,000	9,000,000	580,000
1 x 10^4	580,000	10,900,000	400,000
3 x 10^4	400,000	11,030,000	385,000
1 x 10^5	80,000	255,000	25,000
7 x 10^5	less than 10	4,350	.....
2 x 10^6	less than 10	275	.....

TABLE 7

Effects of irradiation of white cake batter on the amylograph viscosity (30° C. to 90° C.)

Treatment (rep)	Amylograph peak viscosity (Brabender units)
Control	790
1 x 10^4	760
3 x 10^4	690
1 x 10^5	540
2 x 10^6	80

TABLE 8

Initial baking performance of irradiated dry cake mixes

Treatment (rep)	Dry mix observations	Batter observations	Grain and texture of baked cake	Volume (cc.)
White Cake Mix				
Control	Normal	Normal	Good	1100
5 x 10^4	Normal	Normal	Good	1100
1 x 10^5	Slight lard odor, brown egg shell color	Slightly dark otherwise normal	Good	1100
5 x 10^5	Lardy odor, brown egg shell color	Slightly dark otherwise normal	Slightly compact, slight off odor	970
1 x 10^6	Rancid odor and dark brown color	Tan color, consistency normal	Very compact, bready and dark color. Slight off odor	800
Spice Cake Mix				
Control	Normal	Normal	Good	1180
5 x 10^4	Normal	Normal	Good	1140
1 x 10^5	Slight off odor	Normal	Good	1160
5 x 10^5	Slight off odor	Normal	Slight compact grain, slight off flavor	1100
1 x 10^6	Pronounced off odor	Normal	Compact, off flavor	1000

TABLE 9

Initial bacteriological counts of irradiated dry cake mixes

Treatment (rep)	White cake mix		Spice cake mix	
	Bacteria/g.	Molds/g.	Bacteria/g.	Molds/g.
Control	67,000	45	2,650	30
5 x 10^4	355	30	125	15
1 x 10^5	245	less than 10	115	less than 10
5 x 10^5	less than 10	less than 10	15	less than 10
1 x 10^6	less than 10	less than 10	less than 10	less than 10

TABLE 10

Initial amylograph determinations on irradiated dry cake mixes (30° C. to 90° C.)

Treatment (rep)	Amylograph peak viscosity (Brabender units)	
	White cake mix	Spice cake mix
Control	760	690
3 x 10^4	540	660
1 x 10^5	390	460
5 x 10^5	150	110
1 x 10^6	60	50

SUMMARY AND CONCLUSIONS

At the levels of irradiation that would be required to cause an appreciable decrease in numbers of bacteria, the color, the odor, and baking characteristics of the

cake batters were markedly changed. Changes in color and odor also showed up on subsequent storage of batters irradiated at low levels (3×10^4 and 5×10^4 rep). Irradiation of cake batters up to 2×10^6 rep had no effect on alpha amylase activity of the batters; however, at this high level, the gelatinization properties of the starch were markedly changed. There was no change noted by analyses in total sugar, reducing sugar, fat, iodine value of the extracted fat, monoglycerides, acidity or pH of the irradiated batters at any of the irradiation levels used.

An appreciable reduction in numbers of bacteria was obtained at 5×10^4 rep in dry white and spice cake mixes. Initial bakes prior to storage showed white cake mix made acceptable cakes through 5×10^4 rep. Spice cake mix made acceptable cakes through 1×10^5 rep. At 5×10^5 rep the spice cake was slightly off color, slightly off odor and compact. One million rep resulted in off color, off odor, gelatinous cakes. No change in alpha amylase activity was noted in the dry cake mixes at any of the irradiation levels used.

The gelatinization characteristics of the starch were changed in the dry cake mixes at a high level of irradiation. There was no change initially in the total sugar, reducing sugar, pH, fat, iodine value of the extracted fat, monoglycerides, or acidity of the dry cake mixes.

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Color Evaluation of Canned Tomato Juice with Natural and Artificial Illumination

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(Manuscript received July 12, 1956)

Under the agricultural marketing act of 1946 the U. S. Department of Agriculture is authorized to inspect, certify and identify the class, quality, quantity, and condition of agricultural products.

Inspections for quality and condition of processed fruits and vegetables are made in various field offices and processing plants throughout the country by representatives of this Department. One very important quality factor to be evaluated for both fruits and vegetables is *color*. Despite attempts to perfect objective methods for color measurements of agricultural products, most critical color matching must still be done visually. This inspection work is conducted at all seasons of the year both day and night. Because of these varying working hours and working conditions the quality and intensity of both natural and artificial light vary significantly and make visual evaluation of color difficult if not impossible. Canned tomato juice is one product in which the color is a very important quality factor and the judging of this factor is critical. For accurate work a constant source of light with uniform quality is required.

This study was initiated to ascertain whether or not a source of artificial illumination could be satisfactorily substituted for natural light in judging color of canned tomato juice on the basis of spinning Munsell color discs as outlined in the United States Standards for Grades of Canned Tomato Juice.

EXPERIMENTAL

Color spinners. The color of canned tomato juices was compared visually under daylight and artificial sources of illumination with spinning Munsell papers and then assigned numerical scores. The United States Standards for Grades of Tomato Juice require that the color of Grade A Tomato Juice receive a numerical score of 26 to 30 points when it is equal to or better (as much or more red) than the color produced by spinning a combination of the following Munsell Colors:

R 65% (5R2.6/13) (Glossy finish)
YR 21% (2.5 YR 5/12) (Glossy finish)
N_5 (Glossy finish)
N_6 (Mat finish)

The color requirements of Grade C juice provide a numerical score of 23 to 25 points for juice with a color equal to or better (as much or more red) than the color produced by spinning a combination of the following Munsell colors described above:

R 53%; YR 28%; N_5; N_6

The percentages of R and YR are fixed in the above categories, with the remaining percentages being made up of all of either one of the remaining achromatic colors, or any combination of the two.

A new supply of the above papers (Production numbers R-3578, Y-3555, BN1-3622 and N4-3544) was obtained from

the Munsell Color Company and 6 spinners approximately 3¾ inches in diameter were made from the paper and backed with cardboard. Heretofore the gloss on these papers was not the same from one production number to the next. As a result identically painted papers, with varying degrees of gloss, gave slightly different color impressions. Until this condition could be corrected, uniform color evaluation could not be achieved. Therefore, the manufacturer standardized the gloss of the papers and will maintain this gloss on all subsequent productions. The percentages of the 2 neutral colors may be adjusted, thus permitting the values of the spinners to be varied without theoretically changing the hue, to enable the inspector to more nearly match the varying colors of canned tomato juice encountered in the inspection work. The spinners were assembled as follows:

3 GRADE A spinners
R 65%; YR 21%; N_1 14%
R 65%; YR 21%; N_1 7%; N_4 7%
R 65%; YR 21%; N_4 14%

and 3 GRADE C spinners
R 53%; YR 28%; N_1 19%
R 53%; YR 28%; N_1 9½%; N_4 9½%
R 53%; YR 28%; N_4 19%

They were mounted on vertical shafts of 6 fractional horse power electric motors rheostatically controlled to turn at approximately 2,000 r.p.m.

Illumination. The artificial sources were 2 lights with different filters, both using incandescent lamps at 3,000 degrees Kelvin as source of illumination.[a] A third natural source of light was also used.

1. The best natural daylight available through the north window of the laboratory between the hours of 10 a.m. and 2 p.m. EST was used. No evaluations were made on days on which the sky was overcast or cloudy. Tests were performed only on days when the sun shone brightly with or without a few white clouds. Light meter readings showed this light to have an intensity of 400 to 900 foot candles.
2. The first artificial source of illumination consisted of 4-1,500 watt incandescent bulbs each with a curved blue daylight filter and a diffusing glass beneath housed in a metal case equipped with suitable exhaust fans. Four sets of filters were provided with the light having color temperatures of 6,000, 6,500, 7,000 and 7,500 degrees Kelvin. After preliminary investigations the 7,000 degree Kelvin filter was chosen as the one which gave a source of illumination that made evaluation of the tomato juice color the least difficult. This light was suspended 18 inches above the samples to give an intensity about equal to the intensity of the daylight.
3. The second artificial source of illumination consisted of a 500 watt incandescent bulb with a flat circular cobalt glass filter. This filter was measured on a G. E. Recording Spectrophotometer and the color temperature was calculated to be 7,000 degrees Kelvin. This light was suspended 30 inches above the samples to give an intensity about equal to the daylight. The samples, using the artificial light sources, were viewed in an open front booth painted neutral gray with a black curtain for closing off the natural light.

Samples. Representative samples of tomato juice packed in the various parts of the country were obtained from the following sources:

1. Juices of varying qualities packed by the New York State Agricultural Experiment Station, Geneva, New York from tomatoes grown in New York State.
2. Juices of varying qualities packed by the Ohio State Agricultural Experiment Station, Columbus, Ohio, from tomatoes grown in the state of Ohio.
3. Juices of varying qualities packed commercially in California from tomatoes grown in that state.

Instrumental color measurement. The color values of all samples were read on a Hunter Color and Color Difference Meter standardized against a standard reference tile previously calibrated on the Beckman Spectrophotometer. Reflectance measurements were made on the juice using a viewing cell consisting of a plastic tube 3 inches tall by 2½ inches O. D. cemented to a piece of optically polished glass 4¼ x 3⅝ x ¼ inches. The Color Difference Meter was used without the glass plate, using the L scale, the plastic block with the 2¼ inch circular aperture and the small area illumination (⅜ x ⅝ inch).

The "L" (lightness to darkness), the "a" (green to red) and the "b" (blue to yellow) reflectance readings were taken.

PROCEDURE

The color of the samples was first measured on the Color Difference Meter and then evaluated by the judges. The samples were held in metal containers 3⅜ inches in diameter and 2⅜ inches tall with the inside enameled black, and were given to the judges in random order. To expedite the evaluation, the percentages of color in the spinners were fixed as described above. This gave a range of values to include color of the juices used. The sample container was placed beside the spinner (under the light source) with the surface of the can contents on a plane level with the surface of the spinners. The artificial lights illuminated surface of the sample and spinner at an angle of 90 degrees and the judge viewed from approximately a 45 degree angle. The natural source of light came to the sample and spinner at approximately a 45 degree angle and the judge viewed from a 90 degree angle. Of the 7 judges used in this study, 5 were able to make enough readings to give results that have statistical significance. A total of 107 samples of juice were read in duplicate giving a total of 924 readings by the judges under the different lights. Judges viewed the sample and spinner directly or made the observations through a cardboard tube held to the eye. The tube was 12 inches long by 1½ inches in diameter. The end of the tube next to the sample was equally divided by a cross piece ½ inch wide. This served to mask out the edges of the sample container and the circumference of the spinning disc. Samples were viewed under 3 light sources in random order. Judges were asked to assign 26 to 30 score points, based on the U. S. Standards for Grades of Canned Tomato Juice to juices that had a color equal to or better (as much or more red) than the 3 GRADE A spinners. The color of the spinners was equivalent to 26 score points. A score of 23 to 25 points was given to juices that were not as red as the GRADE A spinner but equal to or better (as red as) than the GRADE C spinners. The color of these spinners was equal to 23 score points. For juices whose color was not as red as the GRADE C spinner a score of 22 points or lower was assigned.

Recording data. The data were recorded as follows:

1. Sample number
2. Light sequence
3. Sample sequence
4. Spinner number
5. Light meter value of daylight
6. Score points
7. Color Difference Meter values.

RESULTS AND DISCUSSION

The average scores for the color of the samples of tomato juice viewed under daylight, lights No. 1 and No. 2 are shown in Table 1.

The average scores for daylight (25.7) and the light No. 1 (25.8) were almost identical while the use of the light No. 2 resulted in a score (26.4) approximately 0.7 points higher.

The correlation between the judges' color score under daylight and light No. 1 and daylight and light No. 2 is shown in Table 2.

[a] Light No. 1—Furnished by Macbeth Daylighting Corp., Newburg, New York.
Light No. 2—Furnished by Keese Engineering Co., San Franciso, California.

The correlation between daylight and light No. 1 (.87) is slightly better than between daylight and light No. 2 (.84), with both correlations being very good. Statistically there is no difference.

Robinson *(1)*, Younkin *(2, 3, 4)* and others have compared the ratio of the Hunter "a" reading and the average difference in score points between the judges' initial and second readings of all samples ranged from 0.0 to 0.4, with an average difference of between 0.1 and 0.2 score points.

This shows that on the average the judges were able to repeat themselves with a great degree of accuracy. In a few instances, variations of 2 score points by individual judges between first and second readings on identical samples were observed during this experiment.

The curve for artificial light No. 1 (incandescent lamp with a special curved blue filter) is shown in Figure 1.

This curve (Figure 1) does not exactly duplicate the daylight curve described above, but except for a small rise at 560 mμ and a slight depression followed by an increase at 650-700 mμ it very closely approximates it.

The curve for artificial light No. 2 with a flat blue filter (7,000° Kelvin) and Tungsten Lamp (3,000° Kelvin) is shown in Figure 2.

This curve (Figure 2) is much less smooth than the previous curve and has a decided rise at the red end of the spectrum, which means that the red wave lengths have a much larger proportion of energy than the other wave lengths.

With all samples the judges were able to evaluate the color equally as well or better under the artificial sources of light than they were able to do under the natural source. From this observation we might conclude that either of the artificial sources could be substituted for natural light. However, there is one other factor that should be considered. Although light No. 2 had a Kelvin reading of 7,000° which was the same as Hunter "b" reading to the judges' score points in a single correlation. The comparison data for this study are shown in Table 3.

The correlation between daylight reading and the a/b ratio was .84 and between the light No. 1 and light No. 2 reading and the a/b ratio were both .86. Although the artificial light sources gave a slightly better correlation, all results were very satisfactory. This represents very little difference statistically.

In order to analyze the data further, a multiple correlation between the judges' score under the different illuminates and the separate "a" and "b" readings also was made. Table 4 shows this multiple correlation to be very good for all sources of light. The light No. 1 was better than daylight and the light No. 2 was better than either.

The first 3 of the tables mentioned show that judges No. 1, 3 and 4 were able to do a better job of evaluating color than judges 2 and 5. However, even the correlations of judges 2 and 5 were quite high and show that all the participants in this study were able to score the color very accurately under the controlled conditions of the test. If field judging could be accomplished with this degree of accuracy it would be very desirable. The

TABLE 1

Average scores of samples of canned tomato juice for color under 3 types of lights by 7 inspectors, April and May 1952

Inspector	Readings[1]	Average scores of samples under		
		Daylight[2]	Light No. 1[3]	Light No. 2[3]
	Number	*Points*	*Points*	*Points*
1	160	25.4	26.1	26.8
2	122	25.5	25.4	26.4
3	214	26.3	26.0	26.3
4	214	26.0	26.1	26.5
5	174	25.1	25.4	26.1
6	----	----	----	----
7	20	24.5	25.0	25.2
8	20	25.5	24.7	25.8
All inspectors	924	25.7	25.8	26.4

[1] A total of 107 samples of tomato juice was used in this test. Each inspector scored each sample and then repeated his reading later. Only inspectors 3 and 4 evaluated all samples used in the test.
[2] Only north light on clear days during the middle of the day was used.
[3] Light estimated to be around 7000° Kelvin.

TABLE 2

Correlation between inspectors' score of samples of tomato juice for color under daylight and light No. 1 and daylight and light No. 2, by 5 inspectors, April and May 1952

Inspector	Readings	Correlation between score under daylight and	
		Light No. 1	Light No. 2
	Number		
1	160	0.87	0.85
2	122	0.86	0.81
3	214	0.90	0.90
4	214	0.90	0.89
5	174	0.84	0.80
All inspectors[1]	924	0.87	0.84

[1] Includes 200 readings each by inspectors 7 and 8 not shown separately.

TABLE 3

Correlation between inspectors' score for color and a/b ratio from Hunter Color and Color Difference Meter, 5 inspectors, April and May 1952

Inspector	Readings	Correlation between inspectors' score and a/b ratio		
		Daylight	Light No. 1	Light No. 2
	Number			
1	160	0.90	0.91	0.88
2	122	0.77	0.72	0.77
3	214	0.88	0.90	0.89
4	214	0.89	0.90	0.90
5	174	0.76	0.86	0.83
All inspectors[1]	924	0.84	0.86	0.86

[1] Includes 20 readings each by inspectors 7 and 8 not shown separately.

TABLE 4

Relationship between inspectors' score for color of samples of tomato juice under each of 3 types of lights and "a" and "b" readings on Hunter Color and Color Difference Meter, 5 inspectors, April and May 1952

Inspector	Readings	Multiple correlations coefficients between inspectors' score and "a" and "b" readings[1]		
		Daylight	Light No. 1	Light No. 2
	Number			
1	160	0.92	0.93	0.90
2	122	0.78	0.73	0.79
3	214	0.89	0.98	0.91
4	214	0.91	0.92	0.93
5	174	0.78	0.87	0.86
All inspestors[2]	924	0.86	0.87	0.88

[1] The relationship described is the general form: score = a + b ("a" reading) + c ("b" reading).
[2] Includes 20 readings each by inspectors 7 and 8 not shown separately.

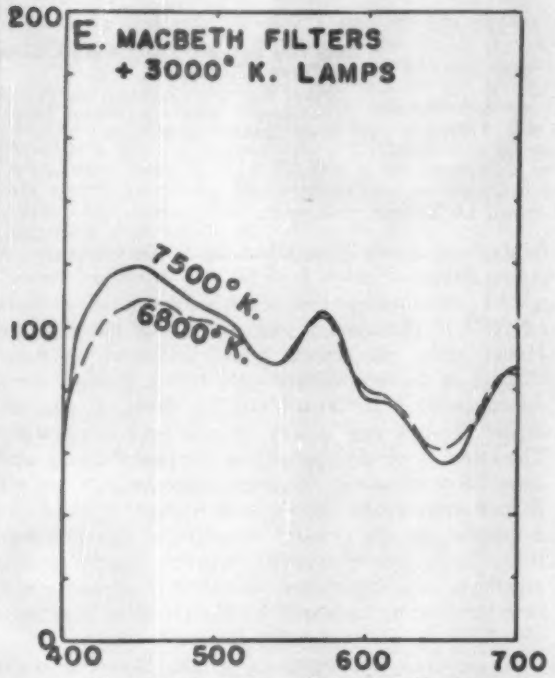

Figure 1. Curve for artificial light No. 1.

the reading for the light No. 1, the spectral energy distribution (Figure 2) curve for this light was extremely uneven and at 650 mμ it rose abruptly and at 660 mμ rose to over 100. This extreme abundance of energy in the red end of the spectrum resulted in the up-grading of all samples by an average of 0.7 score points. Because of this light No. 2 would not be desirable. The spectral energy distribution (Figure 1) curve for light No. 1 shows a profile much more nearly like that of average daylight.

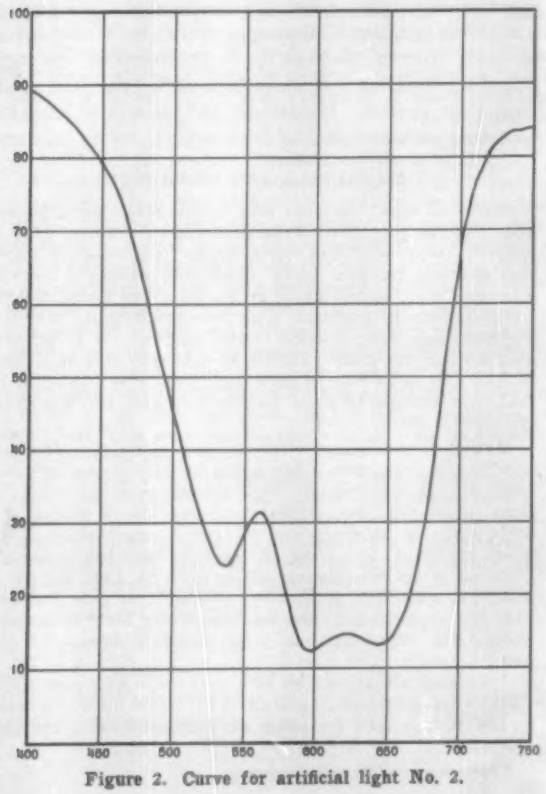

Figure 2. Curve for artificial light No. 2.

In this study only the best daylight for the 4-hour period at mid-day during the months of April and May was used. The judging was not conducted on cloudy or overcast days. In the field it is necessary to do color work both day and night during all the seasons.

Therefore, the use of a satisfactory artificial source of light would greatly extend the working hours of color judging as well as increase the accuracy and uniformity of the color evaluation.

SUMMARY

Using daylight as standard the judges' scores show better correlation between daylight and light No. 1 than between daylight and light No. 2.

Using the Hunter Color and Color Difference Meter as a reference ("a" and "b") shows the correlation for all 3 light sources and the judges' scores to be about equal.

The judges repeated their first and second scoring of the juice more consistently under light No. 1 than under daylight or light No. 2. Their results under daylight and light No. 2 were about equal.

The judges' scores tended to be 0.7 points higher under light No. 2 than under daylight or light No. 1. This was caused by the spectral distribution of the light coming from No. 2, which had an extremely high proportion of wave lengths at the red end of the spectrum.

This study has indicated that it would be feasible to substitute a source of artificial illumination for natural light in the evaluation of color for canned tomato juice. Of the lights tested, light No. 1 would be the most satisfactory substitute.

A standardized gloss on all Munsell papers is mandatory.

Addenda

As a result of this study light No. 1 was chosen as the one which would provide the greatest aid in color evaluation of food products.

One large permanent light of this type and several smaller portable lights have been placed in the Department's Washington laboratory and several of the field offices.

This light has been very successfully used since installation, approximately 3 years ago. The inspectors use this light with confidence and are greatly aided by its use in making critical evaluation of color.

Acknowledgment

The authors thank V. H. Nicholson and staff for assistance on statistical analysis of the data.

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Flavor of Untreated, Oiled, and Thermostabilized Shell Eggs After Storage at 34° F.[a, b]

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(Manuscript received September 13, 1956)

IN BUYING AND SELLING SHELL EGGS, producers, distributors and consumers, all are concerned with egg quality though from different viewpoints. Consumers desire eggs which not only have "fresh egg" appearance and flavor, but which also perform acceptably in baked and cooked products. Producers and distributors are interested in a high percentage of eggs candled as A or AA quality. An investigation of methods whereby candle quality and "fresh egg" appearance would be preserved, superior performance in baked and cooked products assured, and the flavor of the eggs maintained should therefore be of value to all of these groups.

Much progress has been made in reducing the quality deterioration that occurs in marketing of eggs. Since eggs are highly perishable and lose quality rapidly, low temperature storage is used to reduce the rate of deterioration between production and time of consumption. Oiling eggs before storage may be used to retard losses of moisture and CO_2. Thermostabilization, a heat treatment in oil, proposed by Funk *(6)*, is another method used to maintain egg quality. By stabilizing the thick portion of the egg white, eggs retain their fresh appearance even after storage for periods up to 8 months *(4, 7)*.

Funk *(6, 7)*, Goresline *et al. (9)*, and Carlin and Foth *(4)* have reported on the interior quality, the bacterial spoilage, and on the functional properties of stored, untreated, oiled, and thermostabilized eggs. However, the effect of shell treatments on the flavor of eggs has received comparatively little attention.

According to some workers *(10, 13)*, oiling does not adversely affect egg flavors during storage. However, Sauter *et al. (11)* on the basis of taste scores on poached eggs stored 6 months at 32° F. indicate that oil-treated eggs develop more off-flavor than do untreated eggs during storage. They concluded that "oil treatment of shell eggs is of no value in maintaining the flavor of eggs during storage." Forsythe *(5)* found that when eggs were washed in detergent solution, soapy flavors were noticeable in eggs held for 7 days but were not detectable after the eggs were stored for 65 days. In a study on the absorption of foreign odors from packing materials, Gaebe *(8)* reported off-flavors to be more prominent in egg yolk than in the white and dependent upon the humidity of the environment and the pH of the eggs during storage. Sharp *(12)* observed that the lower pH of oiled eggs, as compared to untreated eggs, might have a retarding effect on the development of strong flavors.

Although thermostabilization has been shown to be effective in maintaining egg quality, as measured by Haugh units, no reports could be found on flavor changes in thermostabilized eggs during storage. Since the consumer is concerned with the flavor of eggs, this aspect of shell egg quality appeared to merit study. The effect of oil dipping and of thermostabilizing shell eggs (approximately 18 hours after laying) on off-flavors development during cold storage at 34° F. for 8 months was the primary objective of this investigation. Since the relationship between interior quality and flavor is of importance, the extent of interior quality deterioration, as measured by Haugh units, was noted for all treatments at monthly intervals.

In previous investigations on the flavor of stored eggs, all the eggs appear to have been placed in storage at the same time. Thus, the judges did not make direct comparisons among eggs stored for various lengths of time. Experiments conducted in this manner increase the bias that judges have to overcome by virtue of knowing that at each successive taste session all the eggs are older than at the previous session. The present study was so planned that eggs were put in storage at intervals over a 10-week period; therefore the eggs stored for different lengths of time were evaluated at the same taste session. The judges had no way of knowing how long each sample had been stored.

MATERIALS AND METHODS

Source of eggs. All eggs used in this study were obtained from a special flock at the Iowa State College Poultry Farm in Ankeny. Hens were kept under similar environmental conditions and fed a standard ration. These hens previously had been trapnested and classified into 5 groups according to the albumen height of the eggs produced. Only the eggs from the hens that produced eggs with albumen heights of from 5.5 to 5.9 mm. were used in this study. Ten dozen eggs, gathered at Ankeny on Thursday and Friday of each week from May 14 to July 17, 1953, were brought to Ames the day they were laid and stored overnight at 34° F.

Method of processing. The morning of the day after they were laid, the eggs were taken out of the refrigerator and dirty eggs or eggs with obvious shell defects were rejected. The clean, sound eggs were placed randomly into 3 groups of 3 dozen each for treatment and allowed to warm up to 70° F. before treatment. One group of eggs was oiled before storage; a second group was thermostabilized in oil (130° F. for 16 minutes); and a third group was stored with no shell treatment. This was repeated on Thursday and Friday for 9 consecutive weeks; thus 162 dozen eggs were placed in storage for this study.

A constant temperature oil bath, equipped with a stirrer (No. 4-285),[4] that contained 20 gallons of Carnation BT-90 oil heated to 130° F. was used for oiling or thermostabilizing the eggs.

[a] Journal Paper No. J-2553 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 1026.

[b] Presented before the Fourteenth Annual Meeting of the IFT, Los Angeles, California, June 27, 1954.

[c] Present address: Poultry Department, University of Missouri, Columbia, Missouri.

[4] American Instrument Company.

For oiling, eggs were placed in a standard 3-dozen Car-Pro lifting tray and dipped for 30 seconds in the oil (130° F.). Use of the Car-Pro tray allowed the oil to surround each egg completely. For thermostabilization, eggs in a Car-Pro tray were lowered into the heated oil (130° F.) and rotated slowly for 16 minutes. After treatment, all eggs were returned to flats to drain and cool for approximately 1-1½ hours in a constant temperature room (71° ± 2° F.) with a fan blowing air over the eggs. Then, all the eggs were put into new one-dozen egg cartons for storage. The cartons were marked and placed in egg cases.

The study was designed so that eggs treated each week were assigned to 4 different lengths of storage as follows:

Treatment Date	Months of Storage			
May				
14-15	2	6	7	8
21-22	2	5	7	8
28-29	2	4	5	8
June				
4- 5	2	4	5	8
11-12	1	5	7	8
18-19	1	3	6	7
July				
2- 3	1	3	4	6
9-10	3	4	5	7
16-17	3	6	7	8

By this means, eggs stored for different lengths of time were available for evaluation at the same taste panel session and the judges had no way of knowing how long the samples had been stored.

Objective measurements of raw egg quality. Weight and albumen height of each egg was obtained prior to scrambling. These data were converted to Haugh units on the interior quality calculator described by Brant *et al. (1)* and to albumen indices using a nomogram *(14)*.

Subjective measurements of stored shell eggs. Preliminary tests were given to select a panel of judges able to distinguish the differences between the flavor of fresh and of stored eggs. For these tests, eggs stored at 80-85° F. were used as well as fresh eggs diluted with varying amounts of off-flavor dried eggs. Eggs were scrambled and then evaluated. During selecting and training of judges, triangle tests and scoring tests were used. Of the 11 individuals tested, 6 qualified as judges.

At monthly intervals, eggs were removed from storage and scrambled or soft cooked for flavor evaluation by the taste panel of 6 trained judges. The experiment was designed so that the flavor of a fresh control and of untreated, of oiled, and of thermostabilized eggs stored for two different lengths of time were compared at the same taste-testing session. For each shell egg treatment, 9 replications of tests on scrambled eggs and 4 replications of tests on soft-cooked eggs were made for each month of storage. The egg products were judged in booths designed for subjective analysis. Each booth was enclosed on 3 sides and equipped with fluorescent lights. To mask color differences in the eggs that might bias a judge's evaluation of flavor, red lights were used during the judging of the scrambled and soft-cooked eggs.

The order in which the 6 coded samples were presented to the judges was randomized. The marked fresh control egg was assigned a value of 10 and the other samples were scored according to the degree of difference in flavor that existed between the fresh control and the shell treated or untreated stored eggs. The following scale was used for scoring:

10 = no off-flavor, fresh mild
9–8 = slight off-flavor
7–6–5 = moderate off-flavor
4–3 = definite off-flavor
2–1 = strong off-flavor
-0 = inedible

Scrambled eggs. After objective measurements for broken-out quality were made, eggs from the same storage period and treatment were put into a one-quart Waring blender jar for 25 seconds at 45 volts, controlled by a Varitran voltage regulator (Model V-1). Each sample of eggs was weighed into the top half of a double boiler and the distilled water was added in these proportions:

	Blended eggs	Distilled water
Treated eggs	100 g.	30 g.
Control eggs	150 g.	45 g.

Eggs were cooked in double boilers on a griddle large enough to accommodate all 7 samples. The samples were stirred at intervals during the cooking period (approximately 11 minutes) until they were evenly coagulated and of uniform consistency.

After cooking, each sample was put into a pre-heated earthenware crock in a warming oven to keep it hot until the time it was served to the taste panel.

Soft-cooked eggs. On the day on which soft-cooked eggs were to be tasted, 42 eggs were taken from storage thus providing each judge with a total of 7 eggs, 1 egg from each of 3 treatments for 2 different storage periods and a fresh control egg. All eggs were placed in a standard 3-dozen Car-Pro lifting tray and warmed to room temperature. Immediately prior to serving to the judges, the eggs were completely immersed in a small steam-jacket kettle two-thirds full of boiling water (15 gallons capacity); the steam was turned off, and eggs were cooked for 5½ minutes. Each egg was served in an individual dish marked with the code number of the sample. The egg was broken open by the individual judge just prior to tasting. Yolk and white of the soft-cooked egg were judged separately.

RESULTS AND DISCUSSION

Effect of storage on interior quality of eggs. The appearance of untreated and treated eggs stored for 8 months at 34° F. (Figure 1) illustrates some of the outstanding characteristics observed when the stored eggs were broken out. Although all eggs contain thick albumen, the amount of thin albumen is greatest in the untreated egg and tends to spread more than in the oiled or the thermostabilized egg; the thermostabilized egg has the appearance of a fresh egg.

Measurements of albumen height and observation of the broken-out appearance of the stored eggs indicated that during storage at 34° F. the quality of untreated eggs deteriorated more rapidly and to a greater extent

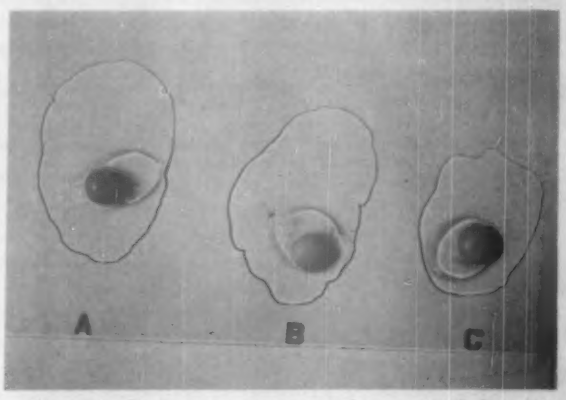

Figure 1. Broken-out appearance of eggs stored for eight months at 34° F.
A—untreated; B—oiled; C—thermostabilized.

than did oiled or thermostabilized eggs. A comparison of the data on eggs stored for 8 months reveals that the quality of untreated eggs decreased an average of 26 Haugh units; for oiled eggs the average decrease was only 12 Haugh units and for thermostabilized eggs only 8 Haugh units. Thus, the shell treatments decreased the amount of deterioration, but did not stop it.

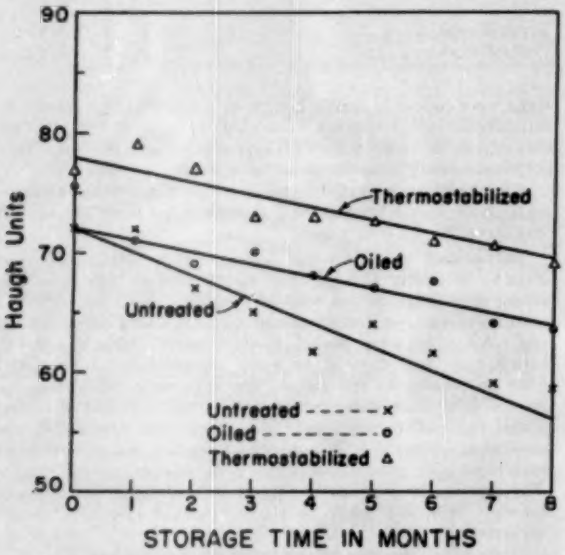

Figure 2. Linear regressions of average Haugh units of treated eggs on storage time.

Although there was a similar downward trend in the quality of all the eggs as storage time increased, the rate at which the interior quality of the eggs declined depended on the shell treatment. As shown by the linear regression of average Haugh units on storage time (Figure 2), the oiled and the thermostabilized eggs declined in quality at about the same rate and at considerably slower rate than did the untreated. Since all eggs were 56 Haugh units or above at the end of 8 months' storage at 34° F. (Table 1), the decrease in interior quality during storage was not great enough to change the average quality grade of the eggs from U. S. grade A to grade B. (According to Brant and Shrader *(2)*, eggs having Haugh units of 55 to 78 should be assigned U. S. Grade A).

TABLE 1

Average[1] Haugh units and albumen indices of untreated, oiled and thermostabilized eggs stored at 34° F.

Storage time	Treatment					
	Untreated		Oiled		Thermo.	
	H.U.	A.I.	H.U.	A.I.	H.U.	A.I.
1 week	73	60	75	65	78	70
1 month	72	59	71	58	79	73
2 months	67	51	69	54	77	68
3 months	66	49	70	55	73	62
4 months	62	44	68	52	73	62
5 months	64	46	67	50	72	59
6 months	62	43	68	52	71	57
7 months	59	40	64	47	71	56
8 months	56	37	64	46	69	53
Regression	—1.935		—1.245		—1.157	

[1] Average = 48 eggs at one week; 18 eggs at all monthly intervals.

Analysis of variance indicated that both treatment and storage time had a highly significant effect on the interior quality of eggs from all treatments. In addition, the high negative correlation coefficients obtained: (a) untreated eggs, $r = -0.947$, (b) oiled eggs, $r = -0.933$ and (c) thermostabilized eggs, $r = 0.947$ indicated a close relationship between decline in quality and storage time. These results differed from those reported previously by Carlin and Foth *(4)* who found that treatment effect was independent of the storage periods. However, their investigation was conducted under commercial conditions, current receipt eggs were oiled and were thermostabilized several days after they were laid and then stored in a commercial warehouse. The initial quality of the eggs used in their study, as determined by albumen index, was between 35 and 45, whereas, in the present study, the initial quality of eggs was higher (albumen indices of from 60 to 65) and the eggs were treated 18 hours after laying (Table 1). Thus, the amount of deterioration in shell treated eggs during storage is related to the initial quality of the eggs. Funk *(7)* reported similar results in a study on the effect of thermostabilization on maintaining the quality of grade A, B and C eggs held at room temperature.

TABLE 2

Effect of shell treatment and storage at 34° F. on the average scores[1] for flavor of scrambled eggs and of soft-cooked egg yolks and whites

Treatment	Storage months	Average flavor scores		
		Scrambled eggs	Yolks	Whites
Untreated	1	8.9	9.0	9.3
	2	8.8	8.9	9.3
	3	8.0	8.1	8.1
	4	7.8	7.9	8.0
	5	6.5	7.1	7.1
	6	6.2	5.5	6.2
	7	6.3	5.7	5.9
	8	5.6	6.2	6.5
	Regression	—.497[2]	—.527[2]	—.515[2]
Oiled	1	8.8	8.5	7.8
	2	8.1	9.2	8.3
	3	7.2	7.1	6.6
	4	6.6	7.2	6.1
	5	5.7	6.3	5.3
	6	4.5	5.5	4.9
	7	4.8	5.4	4.7
	8	4.2	4.9	4.3
	Regression	—.693[2]	—.658[2]	—.566[2]
Thermo-stabilized	1	9.2	9.0	8.3
	2	8.4	8.8	7.8
	3	7.6	8.0	6.8
	4	6.7	7.5	6.4
	5	6.0	6.7	5.9
	6	5.5	5.5	5.0
	7	5.0	5.3	4.9
	8	4.1	5.0	4.8
	Regression	—.706[2]	—.641[2]	—.543[2]

[1] Each average score represents 54 judgments for scrambled eggs; 24 for soft-cooked eggs.
[2] Significant at the 1 percent level.

Effect of shell treatment and storage time on the flavor of scrambled eggs. Average taste panel scores for the flavor of scrambled eggs prepared from stored untreated, oiled, and thermostabilized eggs indicated that there was an increase in the off-flavor of all eggs as the storage time progressed (Table 2). However, lower flavor scores for oiled and for thermostabilized

eggs than for untreated eggs indicated a greater degree of off-flavor in treated eggs. Analysis of variance of the flavor scores for scrambled eggs revealed that both shell treatment and storage time had a highly significant effect on flavor.

Since the regression values were —0.693 for flavor of oiled eggs, —0.706 for thermostabilized eggs and —0.497 for untreated eggs (Table 2), one concludes that the flavor of untreated eggs deteriorated less rapidly than did the flavor of treated eggs (Table 2 and Figure 3). A comparison of the data on Haugh units and flavor scores indicates that in this study the eggs that decreased the most in Haugh units scored highest in flavor and vice versa.

Effect of shell treatment and storage time on the flavor of soft-cooked eggs. A comparison of the average flavor scores for soft-cooked eggs for each storage period (Table 2) reveals that the whites of soft-cooked untreated eggs scored from 1 to 2 points higher than the whites of treated eggs. On the other hand, the flavor scores for yolks were similar for all treatments for the first 2 months and later only differed by approximately 1 point. Analysis of variance indicated that the off-flavor in the oiled and in the thermostabilized eggs was significantly more pronounced in the egg white than in the egg yolk.

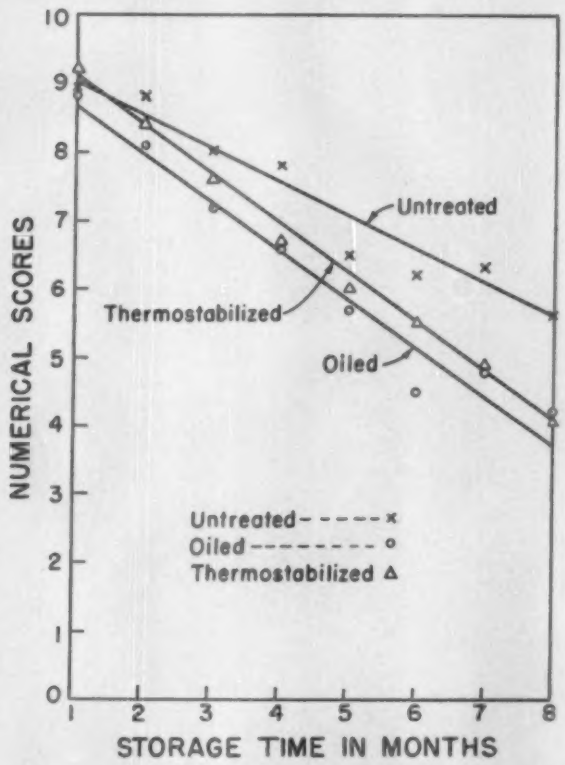

Figure 3. Linear regressions of flavor scores of scrambled eggs on storage time.

Linear regressions of average flavor scores of the whites and the yolks of soft-cooked eggs on storage time showed that the flavor scores of untreated eggs were significantly higher than scores of either oiled or thermostabilized eggs (Figure 4).

High negative correlation coefficients for each treatment for soft-cooked eggs indicated that the flavor of the yolks as well as the whites was significantly affected by storage.

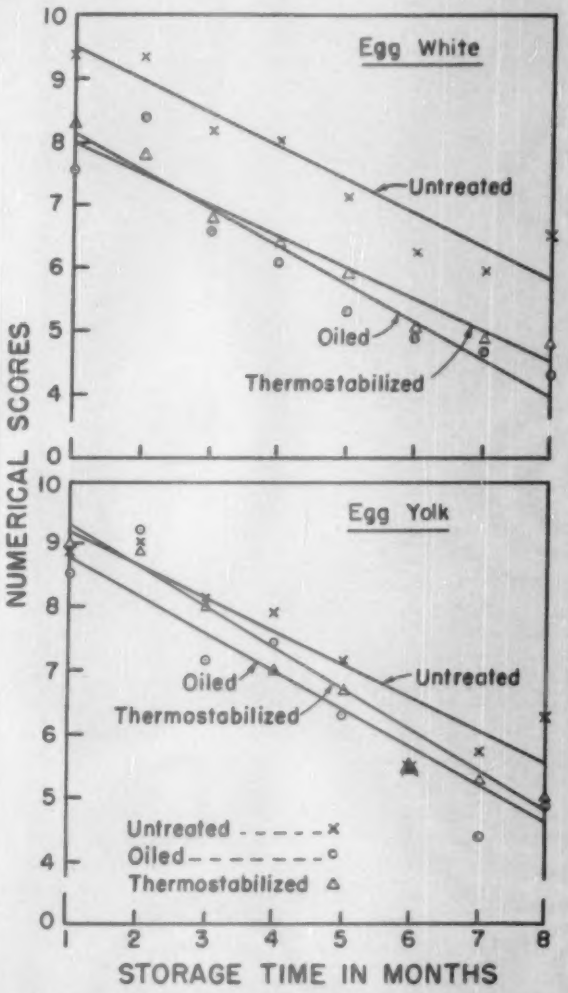

Figure 4. Linear regressions of flavor scores of soft-cooked egg white and yolk on number of months in storage.

At each storage period the flavor of the white of untreated soft-cooked eggs was scored higher than the yolk, whereas the reverse was true for the treated eggs. However, although all the eggs deteriorated in flavor during storage, the flavor scores given to both the yolk and the white of soft-cooked untreated eggs always were highest and of the oiled eggs the lowest. Similar results were obtained by Sauter *et al. (11)*. On the other hand, Slocum *et al. (13)* found that oiling did not adversely affect the flavor of eggs stored 9 months at 30° F. The observation by McIntosh *et al. (10)* that the flavor of the whites of three-month-old oiled eggs

was superior to the flavor of the whites of 3-month-old oiled eggs was superior to the flavor of yolks in these eggs was not supported by data obtained in the present study.

Two possible explanations for the off-flavor found in the treated eggs are: (1) the oil acts as a carrier or a wick to transfer odors from the environment into the eggs, or (2) the products of deterioration cannot escape as readily in the treated eggs because the pores of the shell are filled with oil. Further investigations are being conducted in an attempt to test these inferences. Whatever the cause, results obtained under the conditions in this study indicated that after storage for 8 months at 34° F., untreated eggs have a superior flavor to that of oiled eggs or of thermostabilized eggs stored under similar conditions and that a negative correlation existed between flavor scores and Haugh units.

SUMMARY

Untreated, oiled, and thermostabilized eggs stored at 34° F. were evaluated at monthly intervals up to 8 months to determine differences in the interior quality and in the extent of flavor deterioration. The experiment was so designed that the flavor of untreated, oiled and thermostabilized eggs stored for 2 different lengths of time were compared at the same taste testing session.

During the 8 months of storage, eggs from all 3 treatments—i.e., the untreated, the oiled, and the thermostabilized eggs—declined significantly in interior quality as measured by Haugh units. However, untreated eggs declined more in quality than did treated eggs. Hence, it was shown that both dipping in oil and thermostabilization retard losses in interior quality as measured by Haugh units.

A highly significant negative correlation existed between length of storage and decrease in the flavor scores of both untreated and treated eggs. As storage time increased, off-flavors were more evident in oiled and in thermostabilized eggs than in untreated eggs. Hence, after 6 months, the flavor of the stored untreated eggs was superior to that of the stored treated eggs, when such eggs were scrambled or soft-cooked. When stored oiled and thermostabilized eggs were soft-cooked, the off-flavor was more detectable in the egg white than in the egg yolk.

Acknowledgments

The authors wish to acknowledge the assistance of Professor Paul G. Homeyer of the Statistical Laboratory in setting up the experimental design and in the analysis and interpretation of the data. Appreciation is extended to the members of the taste panel for their cooperation; also to L. Sonneborn and Sons, Inc., Chicago, Illinois, for supplying the Carnation BT-90 oil.

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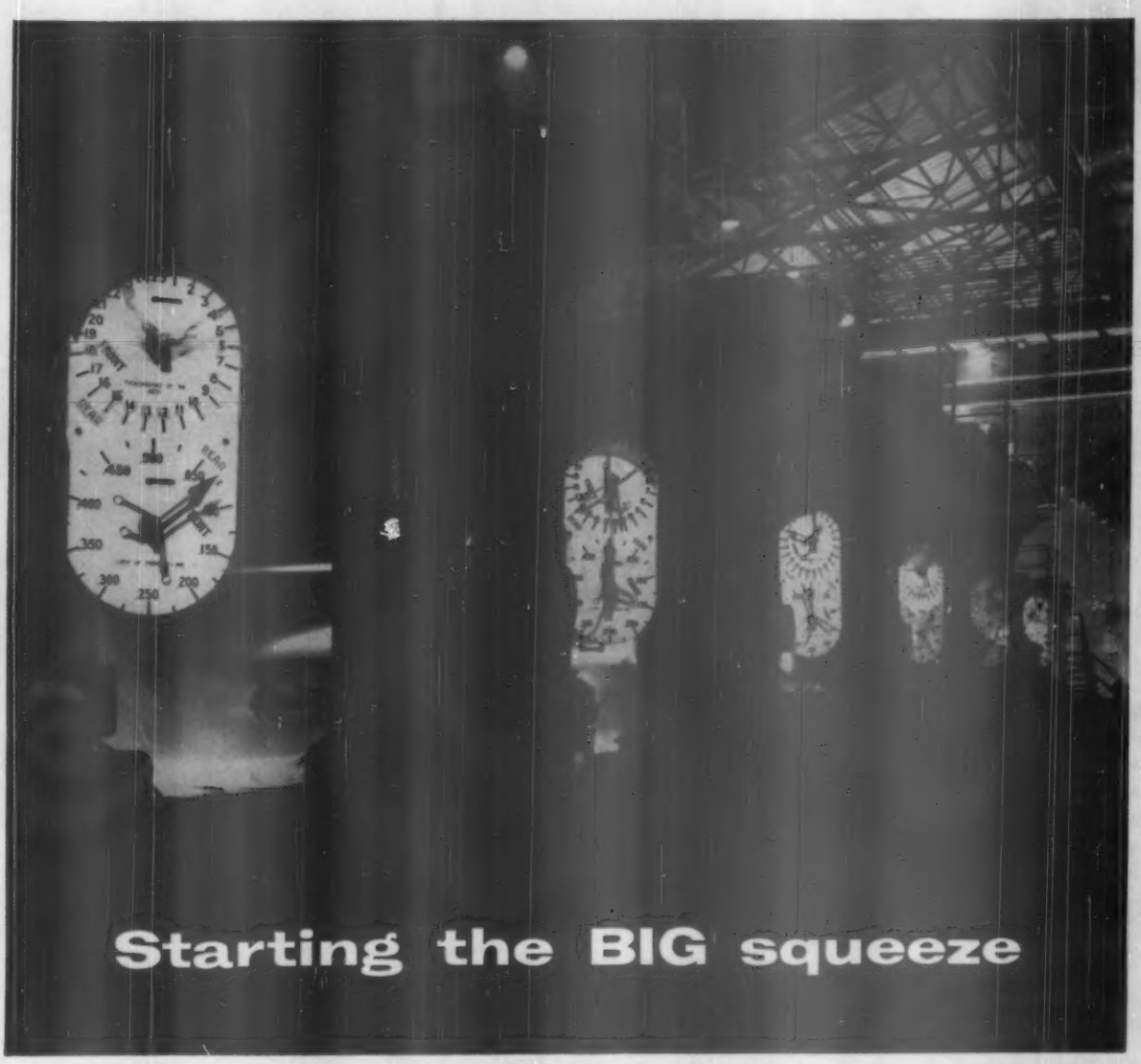

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MEMBERSHIP

Write to nearest regional secretary, if within an area covered by a regional section, or to the Executive Secretary of the Institute for an application form and information regarding qualifications and classifications.

every old crow thinks her babe is Bee-u-tiful

"Mother-Love" sometimes, and quite naturally, rationalizes the poor sales behavior of a food product where flavor and eye appeal may be out-of-step with changes in consumer preferences.

It is important to know the truth about *your* product...it is just as important to know what to do about the truth! May we suggest "Better Check with STANGE and Be Sure."

The **WM. J. STANGE CO.**, *Manufacturers of Seasonings and Food Color, extends to the Food Industry a three-fold service involving Flavor and Color Improvement—Product Development —New Product Suggestions. Any or all three services are available through a Stange representative or by letter.*

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SELECTED ABSTRACTS . . .

Compiled by H. A. Campbell

ANALYTICAL METHODS

Rapid procedure for estimation of amino acids by direct photometry on filter paper chromatograms. Estimation of seven free amino acids in orange juice.

ROCHLAND, L. B., AND UNDERWOOD, J. C. (U.S.D.A., Philadelphia, Pa.). *Anal. Chem., 28,* 1679-84 (1956).

An improved procedure is presented for the direct photometric estn. of free amino acids on small-scale filter paper chromatograms. The estn. of total spot density is facilitated by a device for mounting the paper chromatograms in the sample chamber and in front of the photocell of the photometer. Complete amino acid assays are obtained within a 24-hr. period. The assay range is 0.1 to 1.0γ for solns. contg. as little as 150γ per ml. Values are presented for alanine, γ-aminobutyric acid, arginine, aspartic acid, glutamic acid, and proline in the filtered juices of California Valencia and Washington Navel oranges.

Separation of egg white proteins by paper electrophoresis.

EVANS, R. J., AND BANDEMER, S. L. (Michigan State Univ. of Agr. and Applied Sci., East Lansing.) *J. Agr. Food Chem., 4,* 802-10 (1956).

A procedure was developed whereby the proteins in whole egg white were sepd. by the technique of Durrum, using a pH 8.6 diethylbarbiturate buffer of 0.05 ionic strength. Fresh egg white contained 65.2% ovalbumin, 11.2% ovomucoid plus ovoglobulin, 17.0% conalbumin, 2.1% nonmobile protein and 4.5% lysozyme. The method is ideal for studying possible changes in egg white proteins during storage, because of its speed and reproducibility of results.

The determination of phenols by chromatography and spectrophotometry of their methyl ethers. 1. Ultraviolet absorption spectra of methyl aryl ethers in cyclohexane.

COMMINS, B. T., AND LINDSEY, A. J. (Sir John Cass College, London, Engl.). *Anal. Chim. Acta, 15,* 446-50 (1956).

Phenols are quantitatively converted into their Me ethers by use of dimethyl sulfate in the presence of alkali. The ethers are then sepd. in cyclohexane soln. by chromatography on alumina columns and are detected by the recognition of characteristic absorption peaks in the u. v. spectra and the measurement of peak heights.

Multiple thickness cell assemblies application to ultraviolet spectrophotometry.

TUNNICLIFF, D. D. (Shell Development Co., Emeryville, Calif.). *Anal. Chem., 28,* 1657-60 (1956).

The use of a single absorption cell with a fixed length is often inefficient for making absorption measurements. Much time can be saved by using a multiple thickness cell assembly consisting of a group of individual cells of different thickness all filled with the same sample. The absorbances are then measured using the most appropriate cell thickness for the particular spectral region. This arrangement eliminates the need for prepg. a different diln. of the sample for each region. Three cell assemblies of this type are described. These include a gas cell for the Beckman DU spectrophotometer and liquid cells for the Cary and the Beckman spectrophotometers.

Refractive index of liquids at elevated temperatures.

LAUER, J. L., AND KING, R. W. (Sun Oil Co. Research Lab., Norwood, Pa.). *Anal. Chem., 28,* 1697-1701 (1956).

Two instruments have been constructed for the abs. detn. of refractive index at elevated temps. One instrument is useful for detns. in the temp. range 25° to 55° C., and the other from 60° to 110° C.

Cone-plate viscometer. Comparison with coaxial cylinder viscometer.

MCKENNELL, R. (Ferranti Ltd., Manchester, Engl.). *Anal. Chem., 28,* 1710-14 (1956).

The cone-plate viscometer provides a rapid means of obtaining reproducible flow measurements on non-Newtonian fluids by subjecting the sample to definite uniform shear rates.

A highly alkaline pH standard.

Tech. News Bull. (NBS), 40, 157 (1956).

To increase the accuracy of pH measurements in the high alk. range, the Bureau is recommending a sixth pH standard for use along with the five pH standards previously established. Consisting of a satd. soln. of $Ca(OH)_2$, the new standard will provide an addnl. fixed point in the standard pH scale which the Bureau maintains. The pH of this soln. is 12.45 at 25° C. and is a rather sensitive function of temp. Although standard samples are not yet available from the Bureau, highly pure prepns. can be readily made from commercially available grades of $CaCO_3$.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

The browning reaction of sugars and amino acids approached by means of simple hydroxy ketones.

HURD, C. D., AND BURSS, C. M. (Northwestern Univ., Evanston, Ill.). *J. Am. Chem. Soc., 78,* 5667-71 (1956).

The general problem of browning of carbohydrates by amino acids or proteins is considered and an explanation is offered based in large measure on results with the model systems. The steps proposed to explain the colored bodies involve an Amadori rearrangement of aldose to the N-analog of the ketose, aldolization and/or oxidation to yield polymers contg. cumulative carbonyl groups (α-diketones, triketones, etc.).

Oxidative decarboxylation of amino acids.

SPENSER, I. D., CRAWHALL, J. C., AND SMYTH, D. G. (The Medical Coll. of St. Bartholomew's Hosp., London, E. C. 1). *Chem. & Ind. (1956), 796-7.*

Oxidation of [αβ-H_2] valine of [αβ-H_2] phenylalanine with NaOCl, H_2O_2, chloramine-T, ninhydrin and alloxan takes place without loss of tritium, yielding resp. [1:2-H_2] *iso*butyraldehyde and [1:2-H_2]-phenylacetaldehyde (assayed as the 2:4-dinitrophenyl-hydrazones) of specific activities identical with those of the parent amino-acids. This result proves that the H on the α-C atom of the amino acid is not involved in the reaction.

Polyol dehydrogenases. 3. Galactitol dehydrogenase and D-iditol dehydrogenase.

SHAW, D. R. D. (Univ. of Otago, New Zealand). *Biochem. J., 64,* 394-405 (1956).

A micro-organism identified as a species of *Pseudomonas* forms adaptive enzymes which oxidize a large no. of polyols. The properties and specificities of the enzymes were studied in cell-free exts. They are diphosphopyridine nucleotide-linked dehydrogenases converting polyols into ketoses. Sorbitol and dulcitol induce the formation of galactitol dehydrogenase, which oxidizes dulcitol to D-tagatose and accounts for the oxidation of other fully hydroxylated polyols contg. an L-threo configuration adjacent to a primary alc. group.

Unusual kinetic consequences of certain enzyme catalysis mechanisms.

KING, E. L. (Univ. of Wisconsin, Madison). *J. Phys. Chem., 60,* 1378-81 (1956).

The simple consequence of the abs. rate theory that the compn. of the activated complex for a reaction is given by the form of the rate law does not apply to all limiting rate expressions arising from certain mechanisms for enzyme-catalyzed reactions. These unusual limiting cases may arise in mechanisms with more than one pathway for producing product (and regenerating the enzyme). Such unusual cases do arise if (a) the enzyme is predominantly present as an intermediate which is part of a reaction pathway *via*

(Continued on page 46)

FOOD INDUSTRY TOPICS

(Continued from page 30 preceding technical papers)

milk; chocolate dairy drink with partially de-fatted milk.) The 1956 year-end production and sales estimate brought the total consumption figure for the year to 186 million gallons—an increase of 31 million gallons in two years. America's school children accounted for much of the increase, since 27 states now permit whole chocolate milk in their Special School Milk Program.

◆ ◆ ◆

Sale of macaroni products during 1956 reached an estimated 1,081,000,000 pounds, the industry's biggest year since World War II. According to the National Macaroni Institute, the steady increases over the past decade principally are attributable to the growing awareness by the public that macaroni products are not fattening.

. . . *things new under the sun*

A method of determining at a fairly low cost just how effective nitrogen packaging would be for particular processed foods is offered by National Cylinder Gas Co., 840 N. Michigan Ave., Chicago 11, Ill.

◆ ◆ ◆

Designed for the chemist's use in his own laboratory, the new Infracord double-beam spectrophotometer brings low cost (less than $5000), high performance infrared analysis within the reach of every company. A compact, self-contained instrument requiring no services other than a 120-v. A. C. power, the Infracord automatically provides spectra in 15 minutes. The unit may be used for fast purity checks of raw materials, for recording the progress of an organic synthesis, for molecular structure elucidation, and for precise quantitative analysis. Several unique features include a high-efficiency light-gathering monochromator and a newly designed radiation source with excellent stability and long life. The instrument provides cancellation of atmospheric background, minimization of stray light, and high resolution. It also is equipped with manual slit adjustment for differential analysis. Write Perkin-Elmer Corp., Norwalk, Conn.

◆ ◆ ◆

Market development engineers at Hercules Powder Company, Wilmington 99, Del., have predicted that packaging materials based on Hi-fax,® Hercules' **new linear polyethylene resin,** will help speed the boom of "heat and eat" food products. Currently, packagers of precooked frozen foods depend primarily on containers of two types, based on either aluminum foil or a polyester-polyethylene film laminate. With the current trend apparently away from foods requiring hot oven preparation in favor of those packaged in watertight pouches which can be warmed in a pan of water, plastic packaging for precooked foods is coming into increased use. Hi-fax, the linear-type polyethylene now available in sizable quantities for packaging use, produces an unusual film with several unique properties. The film has excellent slip characteristics as well as high tensile strength and low

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OTTENS' new imitation spices have the same flavor and appearance as pure spices—yet cost only a fraction as much. What's more, only an expert can tell the difference between Ottens' imitation and the choicest pure spices.

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permeability to moisture and gases. Although not transparent, it can be printed by the usual methods used to mark regular polyethylene, and is heat-sealable. Most important feature, however, is the film's resistance to heats up to 240° F., well above the temperature of boiling water, and its acceptability for direct contact with food products.

◆ ◆ ◆

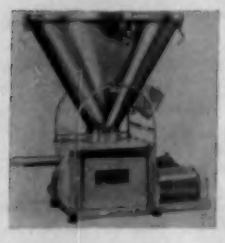
A new transient converter for use with turbine type flowmeters is announced by Fischer & Porter Co., 950 Jacksonville Rd., Hatboro, Pa. The converter accepts a sinusoidal-type input signal of varying frequency and provides either an analog output for recorders and oscillographs or a digital output to counters and computers. Input frequency range for the unit is from 0 to 600 cycles per second, operating from a 500-ohm source impedance. The output is a 0 to 100 millivolt analog signal or a 10 volt positive pulse (at 8 times the input frequency) to digital devices. The unit has a short-term analog accuracy and linearity of ±0.5% and a long-term accuracy of ±3%. Rise time is 10 milliseconds for a 40 to 600 c.p.s. step. Accuracy of the digital output is absolute.

◆ ◆ ◆

For reduced valve maintenance and operating costs, and more precise control, use of duo-seal valves is recommended by Powers Regulator Co., 3434 Oakton St., Skokie, Ill. These pneumatic valves are made for convectors, unit ventilators and air conditioners, and radiators. Instead of packing, they use a bronze bellows as a primary seal, and a spring-loaded neoprene "O" ring as a secondary seal. The bronze bellows, with a 10- to 15-year life expectancy, eliminates leakage found in conventional packed valves and requires no maintenance. Should the packless bellows become damaged, the neoprene ring at its base will effectively prevent steam or water leakage and vacuum loss. This permits normal valve operation until the damaged bellows is replaced. The top of the packless valve is easily removable so that the bronze bellows can be replaced without draining the water system, shutting off steam, or removing the valve from the line. Write for Bulletin Series 348.

◆ ◆ ◆

A low-cost laboratory and pilot plant feeder that will meter out dry materials at any rate from zero to maximum, with an accuracy of ±1% deviation, is being sold for evaluation and application studies in the laboratory and pilot plant by Vibra Screw, P. O. Box 62, Williston Park, N. Y. The pilot plant model, available in screw sizes up to 1½ inches, has the same accuracy as the regular industrial equipment. It controls the density of material before metering, thereby eliminating variations due to aeration, combines accuracy with ruggedness, and defies dirt, dust, and corrosion. Fine powders, flakes, and pellets can be handled without flooding or bridging. There is no degradation in the handling of fine grinds, and delicate crystalline materials are not broken down. Results obtained on the pilot model are reproducible on all industrial sizes from ¼ inch to 10 inches. Further information and prices available upon letterhead request.



◆ ◆ ◆

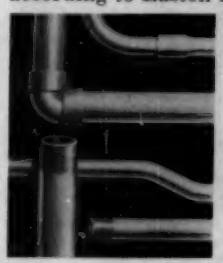
A new concentrated liquid detergent, Oakite Liqui-Det, has been announced by Oakite Products, Inc., 157 Rector St., New York 6, N. Y. Containing no soap, the new product goes into solution instantly and develops copious suds, in hard or soft water, hot or cold, and penetrates the most common soils in a very short time. Furthermore, it can be used repeatedly without rinsing, and without causing any buildup of film or discoloration. Safe on every type of surface and pleasant to the hands, it provides results in concentrations as low as ¼-ounce to the gallon of water.

◆ ◆ ◆

A new method of drying a 100% instant lemon juice has been successfully developed by Jay Food Processing Co., 16 Burroughs Way, Maplewood, N. J., and the company states that it expects to be in full production on its Instant Lemon Juice Crystals by January 10, 1957.

◆ ◆ ◆

Easton Rigid (unplasticized) PVC Pipe now is available in all standard pipe sizes from ¼" to 6", according to Easton Plastic Products Co., Inc., Easton, Pa. The pipe resists corrosion and most chemicals, possesses inertness and purity, and has been approved by the National Sanitation Foundation for use with drinking water. Its chemical properties, combined with desirable mechanical and dielectric properties, have also brought Easton PVC Electrical-Plastic Tubing (EPT) into demand for protection of electric wiring. Easton PVC pipe and tubing can be sawed, threaded, welded, cemented, machined, and formed with conventional equipment. Its weight is only half that of aluminum, one-sixth that of steel; yet it has high structural strength and a tensile strength of 5500 to 7000 psi.



. . . *the literary corner*

History, trade facts, statistics on imports and prices, plus a complete, illustrated encyclopedia on 50 different spices and herbs are contained in "A Treasure of Spices," a 225-page volume just published by the American Spice Trade Assn., 82 Wall St., New York 5, N. Y., and priced at $4.50. Giving industry statistics, the book includes tables and charts on imports, import duties, harvesting seasons, shipping time, and price highs and lows for all major items. In addition to statistics and illustrated information on the individual spices, the encyclopedia contains articles on the role spices are playing in the food field today, the history of spices, spice research, the Pure Food and Drug Law, definitions and stand-

(Continued on page 40)

Pick the Food Executives who do business with *Sterwin*

Many Food Executives (and technologists and engineers, too) are sleeping better, smiling oftener because Sterwin delivers the products they want, when they want them, where they want them. Quick delivery from branches in 10 cities covering the United States and Canada.

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(Continued from page 38)

ards for spices, and tables for postal rates, bank holidays, and distances by water. The volume was edited by Lester W. Jones, a former president of the American Spice Trade Assn.

Food Research Laboratories, Inc., 48–14 33rd St., Long Island City I, N. Y., has available for distribution on letterhead request a booklet entitled "When Why How to Use an Independent Laboratory." Publisher is the Eastern Division of the American Council of Independent Laboratories, of which FRL is a charter member.

A 4-page folder charting structural formulas, properties, composition, and popular applications of the various Tenox antioxidants is being offered without charge by Eastman Chemical Products, Inc., subsidiary of Eastman Kodak Co., Kingsport, Tenn. It is of special interest to processors of foods and allied products having stabilization problems. Among products which already have benefited from the addition of Tenox antioxidants are edible and inedible animal fats, baked and fried foods, candy, cereals, meat meal, starter feeds, vegetable oils, rubber latex, polyethylene, and cosmetics. Since Eastman Tenox laboratory service is available to manufacturers for assistance in the solution of stabilization problems, the folder includes a listing of Eastman representatives to contact throughout the country.

A factual information sheet describing the properties and applications for Hodag Antifoam GY is available on request from Hodag Chemical Corp., 7247 N. Central Park, Chicago 45, Ill. The product is reported to prevent formation of foam in handling and drying such materials as spent yeast from breweries, cheese whey from dairies, and similar food and chemical processing operations. It is stable, edible, and effective in small concentrations.

A new 20-page booklet, "Specifications for Low Temperature Space Installations," Booklet No. FL–101, published by Pittsburgh Corning Corp., 1 Gateway Center, Pittsburgh 22, Pa., contains complete information on the latest recommended methods for installing FOAMGLAS cellular glass insulation on walls, floors, ceilings, and roofs of refrigerated spaces operating between −50° F. and +50° F. It lists suggested thicknesses as well as recommended adhesives, finishes, paints, and other accessories for use with FOAMGLAS in low temperature installations.

A newly revised edition of the reference work, "Guide for Selecting Valves, Boiler Mountings, Lubricating Devices," has been published by Lunkenheimer Co., Cincinnati 14, Ohio. Completely indexed for easy reference, it is identified as Circular No. 555, Valves (A.I.A. File No. 34).

In a new data sheet on pregelatinized potato starch (78–D) and arrowroot (A–78), Morningstar, Nicol, Inc., 630 W. 51st St., New York 19, N. Y., gives valuable application technology and formulations for improving instant puddings, fillings, icings, sauces, soups, and cereals, as well as for developing new food products with such precooked starches. Special interest by makers of foods for grain-allergic people, infants, and invalids is noted.

An abstract bibliography of all publications on research work at the Food Fermentation Laboratory at Raleigh, N. C., has been compiled and is now available for distribution. This laboratory, one of several laboratories of the Southern Utilization Research Branch, Agricultural Research Service, USDA, is engaged in cooperative research on the pickling and brining of cucumbers and other vegetables. Publications on brine preservation of other vegetables, yeasts from meat brines, and preparation of sweet potato silage also are listed. Single copies of *The Brining and Pickling of Cucumbers and Other Vegetables* may be obtained without cost from the SURB, 1100 Robert E. Lee Blvd., New Orleans 19, La., or the Food Fermentation Laboratory, P. O. Box 5578, Raleigh, N. C.

Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa., announces the availability of its new Bulletin 1056 on sanitary liquid and controlled volume pumps. Description of a typical application (syrup metering) is included. The firm also offers Bulletin 1255-B, describing its new line of relief valves and back pressure valves which can be used with corrosive fluid at pressures to 1500 psi and temperatures to 250° F., and Data Sheet B-56-1, describing use of controlled volume pumps for adding filter aid to beer and other liquids prior to clarification.

Publication of the first supplement to its booklet, "Selected Scientific and Engineering Tables and Data," is announced by United States Testing Co., Inc., 1415 Park Ave., Hoboken, N. J. The supplement, like the original 112-page "Tables and Data," contains a wide variety of technical information. Selection of the charts and tables for these publications was based on a combination of their utility and the infrequency of their publication in standard references. Copies of the booklet and its supplement are available by writing on company letterhead to H. M. Block, vice president, at the same address, or to the firm's branch laboratories in Boston, Providence, Philadelphia, Memphis, Denver, Los Angeles, Dallas, and San Angelo, Texas.

Reprints of articles entitled "Refining Cottonseed Oil at High Rates of Shear," and "Pectin Hydrolysis by Salt-Tolerant Yeasts," are offered without cost by Southern Utilization Research Branch, USDA, 1100 Robert E. Lee Blvd., New Orleans 19, La.

How Bunte-Chase Candy Company uses an internal, company-owned telephone system to economically reduce paperwork and speed operations is described in a fact-filled, illustrated bruchure prepared by the manufacturer of P-A-X business telephone systems. Copies are available from J. A. Webber, Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

(Continued on page 42)

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(Continued from page 40)

. . . *meeting hall and conference room*

Three symposia are being arranged for the 48th annual meeting of the American Oil Chemists' Society, to be held in New Orleans, La., at the Roosevelt Hotel, April 29–May 1, 1957. They are: Fats in Nutrition and Health, Tuesday morning; Unit Processes and Operations, Wednesday morning; and a third on technical safety, time to be announced. R. M. Persell and R. T. O'Connor are general chairman and program chairman, respectively. Further details may be obtained by writing the AOCS at 35 E. Wacker Dr., Chicago 1, Ill.

. . . *building up and branching out*

Expansion during 1957 of its collapsible tube, impact extrusion, and aerosol valve division was predicted for Sun Tube Corp., Hillside, N. J., by President Kenneth M. Leghorn. He gave as reasons for his optimistic forecast (1) increased knowledge among manufacturers of the many possible uses of impact extrusions, (2) development of new designs and materials in collapsible tube and aerosol valve production, and (3) Sun Tube's expanding production facilities.

◆ ◆ ◆

A. E. Staley Manufacturing Company's new ultra-modern starch drier building at Decatur, Ill., is equipped with facilities for filtration, drying, packing, and loading of starches for industrial uses. Designed and engineered by Staley engineers and techniciana, the building is a 10-story, 3-level structure of concrete and steel, with continuous horizontal and vertical sections of blue, translucent fibre-glass for illumination. Although the building will increase considerably the firm's capacity for processing oxidized and other modified starches, its primary purpose is to improve starch quality through use of the latest developments in starch-processing equipment. Also included in the installation are many innovations initiated by Staley engineers to provide such improvements in quality as: reduced contamination by other starches, reduced impurities, better starch color, lower ash content, increased uniformity, and better dispersibility. The new installation makes full use of automation and other labor-saving equipment. Processing systems are operated by centrally located panels, and electric interlock connections insure that components of the system are started or stopped in proper sequence. Similarly, automatic shutoffs and level controls provide for immediate stoppage in case of emergencies.

◆ ◆ ◆

McCombs Supply Co., 1819 Wazee St., Denver, Colo., has been appointed manufacturer's representative for Jamison Cold Storage Door Co., Hagerstown, Md., oldest and largest manufacturer of cold storage doors in the world. McCombs will represent Jamison in the entire Rocky Mountain area.

Joseph Morningstar, center, board chairman of Morningstar, Nicol, Inc., handles the trowel at the dedication of the firm's new Hawthorne, N. J., starch- and gum-treating plant on the 105th anniversary of the founding of the firm. Geo. J. Muller, left, president, and Murray Stempel, executive vice president and builder of the adhesives subsidiary company, Paisley Products, Inc., look on. The new facility is the latest link in the 9-plant production network of Morningstar, Nicol, and Paisley, and the last step in a 1956 expansion program involving more than $1 million.

◆ ◆ ◆

Lee Cahn, formerly chief project engineer for Beckman Instruments Inc., has announced formation of the Cahn Instrument Company, with headquarters at 7712 Danvers St., Downey, Calif., and laboratories and plant at 11408 Brookshire Ave., Downey. The new firm will design, manufacture, and sell scientific instruments. Its products, which will be distributed by scientific apparatus dealers throughout the world, include a revolutionary new microbalance considerably faster and more rugged than previous types, and equipment for the automation of other weighing operations in the laboratory. The company also will have a department for the custom design and manufacture of special research instrumentation. Mr. Cahn was responsible for design of the Beckman DK-1 and DK-2 ultraviolet-near infrared automatic recording spectrophotometers, the Beckman 1R2A and 1R4 infrared recording spectrophotometers, the Beckman EASE computer, and numerous other instruments and accessories. Previously, he was in charge of test equipment development for North American Aviation, Inc., and head of the Development Department of Askania Regulator Co.

◆ ◆ ◆

American Can Company reports it has undertaken a broad program of overseas manufacturing operations and expansion of its export sales of containers made by the firm in the U.S. Wm. C. Stolk, president, announced as a first step in the program the organization of Metalgrafica Canco, S.A., a can-making company with a manufacturing plant at Sao Paulo, Brazil. Canco's interests in the Brazilian plant will be held by a wholly owned Canco subsidiary, American Can International, Inc., of Panama. Other overseas operations include Canco's interests in Envases Venezolanos, S.A., Venezuelan can-making firm established in 1953. Technical-assistance agreements also exist with can companies in eight foreign countries—Denmark, Germany, France, England, Mexico, New Zealand, Australia, and Japan—and similar agreements currently are being negoti-

(Continued on page 44)

Griffith's "G-15" and "G-16" Antioxidants for

More Oxidative Stability For More Foods At Low Cost . . . . . .

Shortening • Lard
Fish • Chicken
Peanut Oil • Olive
and other Vegetable Oils • Citrus Fruit Flavors and Essential Oils

Compare the Performance of these Formulas with that of Any other Antioxidant

	"G-15"	"G-16"
Highly effective in retarding oxidation for long period in low concentration	YES—Contains Propyl Gallate	YES—Contains Propyl Gallate
Excellent "carry-through" stability after exposure to high (baking) temperatures	YES—Contains BHT and BHA	YES—Contains BHT and BHA
Non-toxic	YES	YES
Imparts no flavor, odor, or color	YES	YES
Develops no flavor, odor, or color during its stabilizing life	YES	YES
Doesn't cause metal-reactive discoloration of product	YES—Contains Patented Lecithin-Citrate	YES—Contains Monoglyceride-Citrate
Oil-soluble	YES	YES
Water-soluble	—	YES
Reasonable in cost	YES	YES
Packed in convenient non-returnable drums	YES	YES

We'll be glad to consult with you in selecting the proper antioxidant for most effective and economical stabilization of your products. Write us.

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(Continued from page 42)

ated with companies in a number of other countries. Mr. Stolk explained that the technical-assistance agreements make available to foreign licensees on a royalty basis Canco's know-how in research manufacturing, food technology, agronomy, and merchandising. They also provide for furnishing Canco production machinery and the services of company technicians for on-the-spot assistance, and the training of foreign personnel in Canco facilities in this country. These operations will be supervised by a newly created International Division, which also will handle the operation of Canco's Puerto Rican plant, now under construction at San Juan, and will be responsible for expanding overseas sale of American Can's U.S.-made containers.

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American Cyanamid Company has announced that Acronize, its food freshness process based on the antibiotic, Aureomycin chlortetracycline, will be marketed through its new Farm and Home Division which went into operation January 1, 1957. Since it was first approved and placed on the market for commercial use by poultry processors in November 1955, Acronize has been sold through the Food Industry Department of the firm's Fine Chemicals Division. The department name, and the executive, technical, and sales personnel, are incorporated into the new division. The Farm and Home Division, formed by transferring the Animal Feed and Food Industry departments from the Fine Chemicals Division, the veterinary product sales from the Lederle Laboratories Division, and by the inclusion of some agricultural chemical products, emerges as a step in the continuing program of implementation and modification of Cyanamid's organizational set-up. In addition to Acronize, the division will sell antibiotic, vitamin, and medicated feed supplements to the feed manufacturing industry; a wide line of veterinary products; and some packaged agricultural chemicals.

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Completely safe vaccines for treatment of polio and a variety of diseases ranging from rabies to arthritis are produced from the new ultra violet sterilizer, pictured above, according to Dr. Franz Oppenheimer, right, who, with the late Dr. Sidney O. Levinson, invented the instrument at the Michael Reese Foundation in Chicago. Dr. Oppenheimer is shown demonstrating the sterilizer to Maurice C. Hanafin, general manager of the Spinco Division of Beckman Instruments, Inc., Palo Alto, Calif. The newly developed sterilizer spins virus suspensions into a thin film and inactivates the virus in a bath of ultra violet light. Spinco reportedly was selected to manufacture the unit because of the company's broad experience in the field of rotating instrumentation for medical research.

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Evans Research and Development Corp., 250 E. 43rd St., New York 17, N. Y., has joined the American Council of Independent Laboratories, Inc., an association of 75 of the country's largest independent scientific laboratories which accepts as members only those commercial research, development, analytical, testing, and inspection organizations that maintain a high standard of services and subscribe to a strict code of professional ethics. An important factor in Evans' decision to join was the vigorous stand that the ACIL has taken against the tax-favored competition from nonprofit research institutes and universities that are increasing their activities in commercial development and applied research.

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An on-the-job training program designed as an answer to present-day shortages in technical manpower is being offered its technical personnel by the Quartermaster Food and Container Institute for the

(Continued on page 58)

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WHY SHOULD THE VITAMIN C CONTENT OF FRUIT AND VEGETABLE JUICES BE STANDARDIZED?

Because nutrition reports disclose that—

- **Vitamin C deficiencies exist throughout the country***
- **Scurvy has not disappeared from the United States***

Proof of deficiencies among adults and children. You should know these facts!* Diet surveys from Maine and Vermont, New York, Illinois, New Mexico, Oregon, West Virginia, and Texas show a definite pattern of inadequate vitamin C intake. These studies covered grade school and high school children, college men and women.

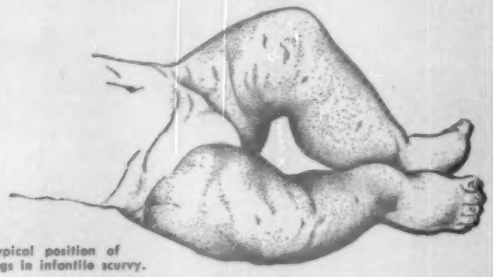
Spongy, swollen gums symptomatic of scurvy.

From these studies* of dietary habits and physical conditions there is considerable proof that many of the children and adults covered by survey have actual, physical symptoms of vitamin C deficiency.

Infantile scurvy. Scurvy* occurs, even today, among infants who are artificially fed. Fortunately the disease may be cured by the administration of vitamin C. How much more sensible it is to prevent it by supplying these bottle-fed infants with the daily allowance of 30 milligrams of vitamin C as recommended by the Food and Nutrition Board of the National Research Council for children under one year of age.

Symptoms of infantile scurvy are fretfulness and fear of being touched.

These bottle-fed infants, unless receiving a pediatric prescription containing vitamin C, are largely dependent on supplemental ascorbic acid which they receive from fruit or vegetable juices. Unless fortified with vitamin C many of the processed juices may not supply these babies with adequate quantities of this essential element.



Typical position of legs in infantile scurvy.

What can be done? Because of the increasing evidence that American diets are deficient in vitamin C, leading nutrition experts believe that processed fruit and vegetable juices, on which the public is so reliant for its supply of this necessary vitamin, should contain the "Vital Ingredient."

The Vital Ingredient of any processed fruit or vegetable juice is a *dependable* and *adequate* supply of vitamin C. You can give your juice this ingredient by *standardizing its vitamin C content*. The processing is simple and the new low cost of ascorbic acid makes juice standardization more attractive than ever.

With ascorbic acid available *by the tons* at extremely modest cost fruit and vegetable juices can have a standardized vitamin C content for the better protection of the nation's health and well-being.

*Statements are based on documented reports. References on request.

Illustrations after photographs in The Vitamins in Medicine by Bicknell and Prescott, Third Edition, published by Grune & Stratton, Inc., New York.

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(Continued from page 36)

which most of the product is not being formed and (b) the predominant form of the enzyme is not in equil. with any intermediate along the reaction pathway *via* which most of the product is being formed. Alternate pathways in enzyme-catalyzed reactions cannot, therefore, be considered to be independent of one another as is true for alternate reaction pathways in uncatalyzed reactions.

A schematic method of deriving the rate laws for enzyme-catalyzed reactions.

KING, E. L., AND ALTMAN, C. (Univ. of Wisconsin, Madison). *J. Phys. Chem., 60,* 1375-8 (1956).

A schematic method of deriving the rate laws for enzyme-catalyzed reactions is described which is particularly useful for treating very complicated mechanisms. It is proved that this schematic method is valid for deriving the rate law for any enzyme catalysis mechanism regardless of the no. of enzyme-contg. species which are involved. Allowance for interactions which do not involve the enzyme is not within the scope of this method but is readily taken into account by usual means.

Solubility and color characteristics of leaf proteins prepared in air or nitrogen.

COHEN, M., GINOZA, W., DORNER, R. W., HUDSON, W. R., AND WILDMAN, S. G. (Univ. of California, Los Angeles). *Science, 124,* 1081-2 (1956).

Browning of leaf exts. can be entirely prevented when all operations during the homogenization and fractionation of leaf exts. are conducted in an inert atm. of high purity N.

Protein interactions with lecithin and cephalin monolayers.

ELEY, D. D., AND HEDGE, D. G. (Univ. of Nottingham, Engl.). *J. Colloid Sci., 11,* 445-50 (1956).

A surface trough was used to study protein/lipid interactions by a development of the Schulman-Rideal injection technique. From the adsorption isotherms obtained the structure of the complexes was detd. The lipids used—distearin, dipalmitoyl cephalin, and distearoyl lecithin —were synthetic materials, and the proteins were bovine plasma albumin and sheep insulin. The results indicated that the first sublayer of adsorbed protein combined with distearin and cephalin through the peptide bonds, probably by means of H bonding or ion-dipole assocn. With lecithin, the interaction appeared to be ionic. In all cases the indications were that a second layer of native protein was adsorbed.

Interactions of ribonucleotide polymers with tobacco mosaic virus protein to form virus-like particles.

HART, R. G., AND SMITH, J. D. (Univ. California, Berkeley). *Nature, 178,* 739-40 (1956).

The nucleic acid appeared to constitute about 4% of the mass. The nucleoproteins further resembled tobacco mosaic virus in that incubation with ribonuclease caused no appreciable hydrolysis of the nucleic acid component. The failure of these nucleoprotein particles to cause disease symptoms is consistent with the current idea that the biol. action of a nucleic acid depends on the exact arrangement of its nucleotide residues. The present results indicate, however, that this arrangement may have little to do with the ability of a ribonucleic acid to form stable, organized complexes with protein.

Fatty acid inhibition of cholesterol synthesis.

WOOD, J. D., AND MIGICOVSKY, B. B. (Sci. Service, Canada Dept. of Agr., Ottawa). *Can. J. Biochem. & Physiol., 34,* 861-8 (1956).

Fatty acids contg. an even or odd no. of C atoms inhibit chlosterol synthesis by a rat liver homogenate. Both satd. and unsatd. acids inhibit. However, the degree of inhibition increases with the degree of unsatn. of the acid. It is speculated that the inhibition occurs at the acetyl Co-A stage in the synthesis.

MICROBIOLOGY

Lethal effects of gamma radiation upon segments of a natural microbial population.

DAVIS, R. J., SHELDON, V. L., AND AUERBACH, S. I. (Univ. of Illinois, Urbana). *J. Bacteriol., 72,* 505-10 (1956).

The effect of γ-radiation upon certain segments of a natural microbial population was investigated. The population studied was the microflora in a tree-hole in a mature beech tree. Seven segments of this population were investigated. Lethality values compared fairly well with those previously reported for pure strains of various organisms. Delayed effect studies indicated that if an entire segment of the population is not eliminated, the population will return in time to equil.

Protection of Escherichia coli against ultraviolet irradiation by catalase and related enzymes.

OGG, J. E., ADLER, H. I., AND ZELLE, M. R. (M. B. Div., Fort Detrick, Frederick, Md.). *J. Bacteriol., 72,* 494-6 (1956).

Direct evidence was obtained which indicates that intracellular catalase and other related iron enzymes, e.g., cytochromes, increase the resistance of *Escherichia coli* to ultraviolet radiation.

The development in vitro of an avirulent, immunogenic variant of Mycobacterium tuberculosis var. hominis.

YOUMANS, A. S., AND YOUMANS, G. P. (Northwestern Univ., Med. Sch., Chicago, Ill.). *Proc. Soc. Exptl. Biol. & Med., 92,* 566-9 (1956).

A variant of the H37Rv strain of *Mycobacterium tuberculosis* var. *hominis* which appears to be avirulent for mice and guinea pigs was developed *in vitro* by continual subculture over 3 years on a N free synthetic medium. This new strain resembled the parent strain both macroscopically and microscopically but differed metabolically from the parent strain in its reduced ability to utilize for growth C compds. related to the tricarboxylic acid cycle. This strain immunized mice as well as the frequently used immunogenic strains H37 Ra and BCG.

Discovery of a new acetate-replacing factor.

SKEGGS, H. R., WRIGHT, L. D., CRESSON, E. L., MACRAE, G. D. E., HOFFMAN, C. H., WOLF, D. E., AND FOLKERS, K. (Merck & Co., Inc., West Point, Pa.). *J. Bacteriol., 72,* 519-24 (1956).

Evidence is presented for the existence of a new factor required in the absence of acetate for the growth of a no. of lactobacilli. Commercial whey, fish solubles, distillers solubles and yeast exts. have been found to be rich sources of the factor as detected by a microbiol. technique.

NUTRITION

The amino acid requirement of the laying hen. II. Classification of the essential amino acids required for egg production.

JOHNSON, D., AND FISHER, H. (Rutgers Univ., New Brunswick, N. J.). *J. Nutr., 60,* 275-82 (1956).

The classification of amino acids according to their essentiality for the laying hen has been studied by use of a free amino acid diet. Arginine, glutamic acid, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine were found to be essential for egg production.

Effects of caloric intake on nitrogen balance and organ composition of adult rats.

ROSENTHAL, H. L., AND ALLISON, J. B. (Rochester General Hosp., Rochester, N. Y.). *J. Agr. Food Chem., 4,* 792-6 (1956).

Restriction in caloric intake, with or without protein in the diet, resulted in depletion in body fat and body protein and an increase in body H_2O in adult rats. The latter was especially marked in the presence of dietary casein. N balance was decreased and catabolic activity increased. Differential changes of body tissues demonstrated that some organs were more labile than others.

The effect of age on the protein and methionine requirements of the rat.

HARTSOOK, E. W., AND MITCHELL, H. H. (Pennsylvania State Univ., Univ. Park). *J. Nutr., 60,* 173-93 (1956).

The protein requirement (casein plus adequate methionine), expressed as a percentage of the diet, decreases in an exponential fashion as age increases from about 14% to about 3.2%. The methionine plus cystine requirement, expressed as a percentage of the protein requirement increases from 7.0 to 8.0%. Evidence presented is unanimous in indi-

(Continued on page 48)

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WRITE FOR BULLETIN 48

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(Continued from page 46)

cating that keratin synthesis assumes an increasingly important role in protein biosynthesis as maturity is approached and later attained.

Nutrition in chronic renal failure.

MERRILL, A. J. (Univ. Med. Sch., Atlanta, Georgia). *Am. J. Clin. Nutr., 4,* 497-505 (1956).

Water intake should be high unless H_2O retention or edema is present. The salt intake should av. about 4 or 5 g. daily. The diet should contain about 0.5 g. per kg. of body wt. of animal protein daily, supplied by a protein of high biol. value, about 3-4 g. per kg. of carbohydrate, and 1-1.5 g. per kg. of fat.

The effect of diet on renal function in healthy men.

SARGENT, F., AND JOHNSON, R. E. (Univ. of Illinois, Urbana). *Am. J. Clin. Nutr., 4,* 456-81 (1956).

Observations on renal function have been collected in 8698 subject-days in 211 healthy young men. Glycosuria is extremely rare. Ketonuria is easily produced by nutritional imbalance, exposure to cold, or hard work. Transient albuminuria may be produced by an unbalanced diet or vigorous exercise, and exposure to cold accentuates this phenomenon. Microscopic hematuria and cylindruria may be produced by unbalanced diets, especially pure carbohydrate or starvation. Caloric deficiency decreases creatinine and urea clearances.

Utilization of ascorbic acid in fruits and vegetables. II. Utilization of 24 fruits and vegetables.

DAVEY, B. L., FISHER, K. H., AND CHEN, S. (Purdue Univ., Lafayette, Ind.). *J. Am. Dietet. Assoc., 32,* 1069-72 (1956).

A study has been made to det. whether the ascorbic acid present in 24 selected foods is as well utilized by human subjects as is synthetic ascorbic acid. The criteria of utilization were: total ascorbic acid in blood plasma or blood serum and total and reduced ascorbic acid in urine. The ascorbic acid from the 24 foods was found to be utilized as well as the synthetic ascorbic acid as judged by these criteria.

Pathology of fat metabolism; phytol, a new lipotropic factor.

BERNHARD, K., AND RITZEL, G. *Z. Physiol. Chemie, 295,* 187 (1953); *Fette Seifen, Anstrichmittel, 58,* 801 (1956).

Formation of fatty livers can be prevented in young rats by the addn. of phytol or isophytol to a choline free, high carbohydrate diet. Oleylalcohol and similar compds. were ineffective.

Skimmed milk acquires liver-necrosis-producing properties during drying. A contribution to dietary liver necrosis in the rat.

FINK, H., AND SCHLIE, I. (Inst. Gargungswiss., Univ. Cologne). *Naturwissenschaften, 42,* 446-7 (1955); *Nutrition Abstr. & Revs., 26,* No. 891 (1956).

Roller-dried skimmed milk produced liver necrosis and death in 16 out of 16 rats. With spray-dried skimmed milk only 5 out of 16 had necrosis and the rest survived. It is concluded that some essential amino acids may be damaged during drying.

PHARMACOLOGY AND TOXICOLOGY

Staphylococcal gastroenteritis.

WAIN, H., AND BLACKSTONE, P. A. (Dept. of Health, Mansfield, Ohio). *Am. J. Digest. Diseases, 1,* 424-9 (1956).

Staphylococcus aureus was found to be the cause of a major outbreak of food poisoning. The offending food was baked ham. The baked ham presented no off-odors, tastes, or flavors. This is characteristic of staphylococcal-infected foods.

PHYSIOLOGY AND MEDICINE

Effect of cortisone on lipid metabolism of plasma, liver and aorta and on retrogression of atherosclerosis in the rabbit.

DURY, A (Bradford Hosp., Bradford, Pa.). *Am. J. Physiol., 187,* 66-74 (1956).

Cortisone was administered daily for 14 days to normal and atherosclerotic rabbits. Determinations were made of lipid distribution and phospholipid metabolism of plasma, liver and aorta of these groups compared with that of untreated, normal and cholesterol-fed animals. Aortas were examd. and judged for severity of atherosclerosis. In cholesterol-fed rabbits the plasma ester cholesterol was significantly depressed. Plasma lipid interrelationships of cholesterol-fed, cortisone injected rabbits were more like normal and different from that of untreated, atherosclerotic rabbits.

Effect of corticoids on the resistance of the kidney to an excess of phosphates.

SELYE, H., AND BOIS, P. (Universite de Montreal, Canada). *Am. J. Physiol., 187,* 41-4 (1956).

Earlier expts. had shown that oral administration of various mono- or dibasic phosphate solns. causes extensive renal calcification in rats. This change is particularly severe in animals simultaneously treated with high doses of desoxycorticosterone acetate (DCA). In unilaterally nephrectomized rats, the substitution of 1.2% NaH_2PO_4 for drinking H_2O rapidly produced marked Ca deposition in the pars intermedia of the kidney. This effect of the phosphate soln. is enhanced by concurrent treatment with DCA and inhibited by cortisol acetate.

Adrenal steroids and the liver in the regulation of peripheral fat mobilization.

TRACHT, M. E., GOLDSTEIN, M. S., AND RAMEY, E. R. (Univ. of Chicago, Ill.). *Am. J. Physiol., 187,* 2-6 (1956).

It is suggested that the liver in some way regulates the movement of fat from storage areas in response to changes in the cal. needs of the animal.

(Continued on page 50)

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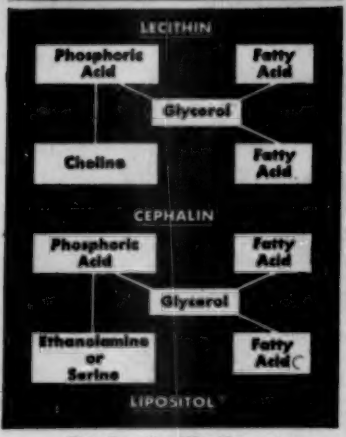

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(Continued from page 48)

Response potentials of vascular tissues and the genesis of arteriosclerosis—A review. Part II B. Lipid-metabolic factors.

BLUMENTHAL, H. T. (St. Louis, Mo.). *Geriatrics, 11,* 514-23 (1956).

Five categories of data are presented as evidence in support of lipid-metabolic factors in the etiology of arteriosclerosis.

ENGINEERING AND PLANT EQUIPMENT

The velocity of evaporation of drops of water.

RADUSCH, R. (Tech. Hochschüle, Karlsruhe, Ger.). *Chem. Ing. Tech., 28,* 275-7 (1956); *Chem. Abstr., 50,* 9809d (1956).

A discussion of the effect of drop size on speed of evapn. and heat-transfer coeff. A drop diam. of 0.35 mm. represents an optimum value for heat transfer when H_2O spray is used for fire-fighting. Some data and 8 references are given.

A simple rotary film evaporator.

MARSH, B. B., AND NOTTINGHAM, P. M. (Dominion Lab., Wellington, New Zealand). *J. Sci. Instr., 33,* 446-7 (1956).

A simple bench-top rotary film evaporator is described with a capacity of 70 ml./hr. of H_2O at 18 mm. Hg and 30° C.

Ultracentrifuge studies on cottonseed protein.

NAISMITH, W. E. F. (Ardil Fiber Factory, Dumfries, Scotland). *J. Appl. Chem., 6,* 283-6 (1956).

Examination of cottonseed protein in the ultracentrifuge has revealed the presence of at least 4 sedimenting components which could not be purified by $(NH_4)_2SO_4$ fractionation.

FOOD AND FOOD TECHNOLOGY

CEREALS AND GRAINS

Investigations of the water-soluble nitrogenous fraction of rice.

MCINTYRE, R. T. (Louisiana Agr. Expt. Sta., Baton Rouge). *Cereal Chem., 33,* 299-302 (1956).

No discrete protein fraction was observed to migrate at pH 4.0, or 8.4 or 10.3. The nonprotein N content of the aq. ext. was found to be 36% of the total H_2O sol. N. This value corresponds to 3.5% of the total N content of the rice.

COFFEE AND TEA

New flavor and aroma for instants.

HEYMAN, W. A. (Heyman Process Corp.). *Coffee & Tea Ind., 79* (11), 97+ (1956).

An announcement by Heyman Process Corp. of a process for producing sol. coffee having the rich aroma and flavor of fresh coffee. The process can control both the type of the flavor and aroma desired, and the quantity of the flavor and aroma. It is claimed that better sol. coffee can be made from cheaper grades than expensive coffee.

FATS AND OILS

Tocopherols as carry-through antioxidants.

DUGAN, L. R., AND KRAYBILL, H. R. (Univ. of Chicago). *J. Am. Oil Chemists' Soc., 33,* 527-8 (1956).

Tocopherols were found to be carry-through antioxidants in lard. Higher levels of tocopherol provide increased carry-through stability although the active oxygen method (AOM) stability of lard is decreased. Combinations of BHA with tocopherol in part provide increased carry-through stability but do not increase the AOM stability.

FRUITS AND VEGETABLES

Novel freeze-enzyme technique peels tomatoes at 6 tons/hr.

STRANIERO, D. (McGraw-Hill World News, Rome). *Food Eng., 28* (10), 58-9 (1956).

Canneries in Italy have a new technique for peeling tomatoes which is said to cut peeling labor a full 70% and boost yield and quality. The tomatoes are plunged into a concd. NaCl brine held at 5° F. for 30-40 secs. This freezes the skin and a layer of flesh below it. The tomatoes are then abruptly plunged into warm H_2O (86° F.) for 8-10 mins. The enzymes released from the broken cells dissolve the pectins which hold the skin to the tomato, leaving the vegetable floating in its skin which can now be easily removed.

MILK AND MILK PRODUCTS

The trace element iron in milk and milk mixtures.

SCHAFER, K. H., BREYER, A. M., AND KARTE, H. (Univ. Gottingen, Kinderklin). *Z. Kinderheilk., 76,* 501-13 (1955); *Nutrition Abstr. & Revs., 26,* No. 210 (1956).

It is suggested that the greater liability to anemia of infants fed on mixts. of cow's milk and oatmeal than of breast-fed infants may be due to interference with Fe absorption by the phosphates of cow's milk and the phytic acid of oatmeal. Soya milk is remarkably rich in Fe (1000 μg. per cent) and this Fe is available, as has been shown by Borngraber, with anemic infants, and by Krause with rats anemic from feeding on cow's milk.

PECTINS

Pectic substances-water. I. Structural changes in the polygalacturonide chains during water adsorption.

BETTELHEIM, F. A., STERLING, C., AND VOLMAN, D. H. (Univ. of California, Davis). *J. Polymer Sci., 22,* 303-14 (1956).

An app. suitable for studying adsorption of H_2O vapor both volumetrically and gravimetrically is described. H_2O vapor isotherms of highly esterified pectin, Na pectate and pectic acid were detd. Equatorial and mediodinal spacings of the x-ray diffraction patterns were measured as a function of equil. H_2O content in these materials. The interchain sepns. as measured by the changes in the equatorial spacings of x-ray reflections,

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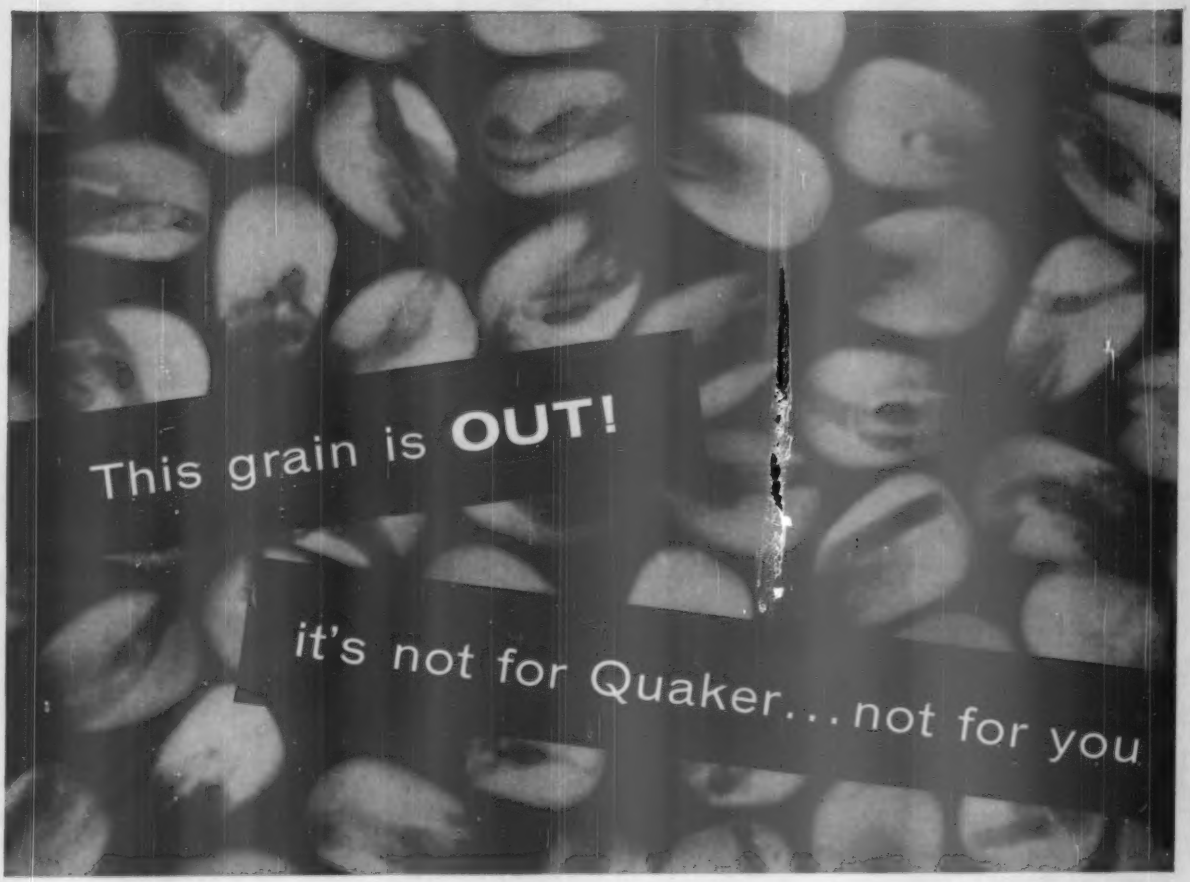

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QUAKER

(Continued from page 50)

follow the shape of the adsorption isotherms. In esterified pectin and Na pectate, the fiber repeat period increases until 5 mols. of H_2O content per 3 galacturonide residues are adsorbed, thereafter remaining const. The fiber period of pectic acid is const. throughout H_2O absorption.

SUGARS AND STARCHES

The fractionation of potato starch by centrifugation in alkali.

BAUM, H., AND GILBERT, G. A. (Univ. Coll. of South Wales, Cardiff, Wales). *J. Colloid Sci., 11,* 428-34 (1956).

Potato starch can be fractionated into its branched and unbranched components by the centrifugation of dispersions of undamaged granules in dil. alkali. The branched component, amylopectin, appears to be completely insol. in this medium, and the unbranched component, amylose, completely sol. There is no evidence to suggest that covalent bonds exist in the granule between amylose and amylopectin. The sepn. of the components by centrifugation is shown to be very efficient because of the exclusion of amylose from the sediment of highly swollen amylopectin particles.

PHYSICAL RESEARCH

On the molecular weight, size and shape of the myosin molecule.

HOLZER, A., AND LOWEY, S. (Yale Univ., New Haven, Conn.). *J. Am. Chem. Soc., 78,* 5954-5 (1956).

Myosin was prepd. in the standard way and complete light scattering, viscosity and ultracentrifuge measurements were made within 60 hrs. after the rabbit's demise. Within this period the ultracentrifuge showed a single peak. Longer storage (at 4°) caused the appearance of a second, faster peak indicating some dimer formation. All the data reported here, therefore, refer to a monodisperse protein. Results for 3 samples are given in the table. The author concludes that the appropriate model is a rod 1650 A.° long, 26 A.° thick, and of mol. wt. 530,000.

Effect of ultrasound on the crystallization of organic substances.

KAPUSTIN, A. P. *Zhur. Tekh. Fiz., 22,* 765-72 (1952); *Chem. Abstr., 50,* 6123c (1956).

The process of crystn. of benzophenone (I), *o*-chloronitrobenzene (II), thymol (III), piperonal (IV), S, salol (V), aq. soln. of NH_4Cl (VI), and condensed milk (VII) (in thin films and in bulk) was observed with a polarization microscope equipped with a camera. According to their responses to the ultrasound these substances could be divided into 2 groups. In the 1st group (I, III, IV, and S) the sound caused a splitting-off of newly formed crystallites; this process was directly proportional to the intensity of the field. The crystals were pushed upwards by the vibrations and formed a cryst. mass that filled the entire melt. This phenomenon took place under various degrees of supercooling and all the way to the m.p. In the 2nd group (II, V, VI, VII) ultrasound caused the breaking of growing crystallites. These fragments served as new centers of crystn. The appearance of the crystals of these substances differed considerably from the appearance of those obtained in the absence of the ultrasonic irradiation. The rate of crystn. of the substances of both groups was several hundred times that under ordinary conditions.

The inhibition of foaming.

ROSS, S., AND BUTLER, J. N. (Rensselaer Polytechnic Inst., Troy, N. Y.). *J. Phys. Chem., 60,* 1255-8 (1956).

Proteins produce foams of outstanding stability by virtue of plastic surface films. The addn. of com. antifoams to protein solns. is shown to reduce or inhibit the normal surface plasticity of such solns.

RADIOCHEMICAL TECHNOLOGY

Wholesomeness and possible carcinogenicity of radiated foods.

TEPLY, L. J., AND KLINE, B. E. (Alumni Research Foundation, Madison, Wis.). *Federation Proc., 15,* 927-9 (1956).

The control and radiated foods were fed for 8 wks. to 10 male rats per group. The foods were mixed with a complete semi-synthetic basal ration at a 35% level on a dry wt. basis. Food consumption records were kept and feed efficiencies calcd. The items tested were: apricots, asparagus, Brussels sprouts, cabbage, cauliflower, celery, cherries, chicken, corned beef, cranberries, crackers, gelatin dessert powder, macaroni, mushrooms, nut roll, pears, peas, pork sausage, potatoes (sweet), potatoes (white), pound cake, salmon, shrimp and tuna. Considering the over-all results of the expts. to date there appears to be no clear evidence of the production of carcinogens on radiation of food materials under study.

Acceptability of irradiated foods. II.

MCGARY, V. E., AND SHIPMAN, M. E. (Fitzsimons Army Hosp., Denver, Colo). *J. Am. Dietet. Assoc., 32,* 1059-63 (1956).

Irradiated foods were fed to human beings in 3-balance studies. Approx. 35, 65, and 80% of the caloric content of the diet was supplied by irradiated foods. Acceptability data was obtained by questionnaire and interviews. Many irradiated foods were as acceptable as non-irradiated control foods. Irradiated fish, meats and fruits were well received by most subjects.

Effects of irradiation on wholesomeness of mixed organ meats in diet of the rat.

BUBL, E. C., AND BUTTS, J. S. (Oregon State Coll., Corvallis). *Federation Proc., 15,* 930-2 (1956).

A two-year, four-generation, feeding, breeding and longevity study on rats fed irradiated or non-irradiated organ meats diet is reported. Four generations of animals were fed these diets without adverse effect upon growth or reproduction. Although the longevity period has not been completed, little difference can be seen between the irradiated and the control animals.

Effect of ionizing radiations on vitamin K.

RICHARDSON, L. R., WOODWORTH, P., AND COLEMAN, S. (Texas Agr. Expt. Sta. Coll. Sta., Texas). *Federation Proc., 15,* 924-6 (1956).

Menadione was more readily destroyed by ionizing radiations than either vitamins K_1 or K_2. When relatively large amts. of the 3 compds. were added to the diet, sufficient vitamin K activity was left after irradiation to prevent hemorrhage. Practically no destruction of vitamin K occurred when a diet contg. dehydrated alfalfa leaf meal was irradiated or when fresh spinach was irradiated. It is concluded that no animal, including humans, receiving irradiated diets composed of natural foodstuffs, would ever develop a hemorrhagic condition because of a deficiency of vitamin K in the diet.

Radiation effects on water soluble vitamins in raw beef.

ALEXANDER, H. D., DAY, E. J., SAUERLICH, H. E., AND SALMON, W. D. (Alabama Polytechnic Inst., Auburn, Alabama). *Federation Proc., 15,* 921-3 (1956).

A summary of the effects of irradiation on H_2O sol. vitamins is given. Values for the vitamins obtained by biol., microbiol. or chem. methods compare favorably with each other. Thiamine was significantly decreased: 67% as revealed by animals, 63% by microbiol. and 60% by chem. method. Some riboflavin was destroyed: 8% as revealed by animal assay and 10% by microbiol. assay. Pyridoxine destruction was calcd. to be 24% when measured by biol. test and 25% when measured by microbiol. assay. Niacin, choline and folacin were not detectably decreased by the ionizing irradiation treatment used.

MISCELLANEOUS

Artificial living plants.

MOBE, E. F. (Bell Telephone Labs., Murray Hill, N. J.). *Sci. American, 195,* 118-26 (1956).

A proposal is given for the development of self-reproducing machines that would be harvested for the materials from which they construct themselves. It would make copies of itself from materials in nature. It is suggested that the first model for the machine be located at the seashore where it could draw on the large variety of materials. Such machines would free mankind's agriculture from dependence on the natural characteristics of plants. These machines might be used to extract valuable metals from the seawater which would be harvested as the crop from the plant. There is a possibility that the whole design problem

(Continued on page 54)

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(Continued from page 52)

could be solved in five or ten years, for as little as $50 million to $75 million.

What's ahead for chemicals from wood. ARNE, F. *Chem. Eng., 63* (11), 282+ (1956).

Rayonier has in its myrecetin (from bark) what seems to be a promising bioflavonoid. Other silvichemicals for sale include vanillin, dimethyl sulfide, rubber reinforcers, oil mud dispersants, EtOH, antioxidants, plastic extenders, emulsion stabilizers and ceramic binders.

PATENTS

Fermentable carbohydrate food products. KING, W. J. Assignor to Colgate-Palmolive Co. U. S. 2,772,168, November 27, 1956.

An improved food prepn. comprising a fermentable carbohydrate food in an amt. normally tending to produce acid therefrom in the oral cavity and having incorporated therein a minor amt. of a higher fatty acid amide of an amino carboxylic compd. to inhibit acid production from the fermentable carbohydrate.

Method of determining uniformity of distribution of physiologically active materials in foods and drugs. COOLEY, M. L. Can. 531,137, October 2, 1956.

Process of prepg. a product contg. a physiologically active material in min. quantity which comprises prepg. a premix contg. the physiologically active material, a sol. nitrite and a carrier, thoroughly agitating the premix to secure uniform compn., adding the premix to the remaining ingredients of the product, and thoroughly agitating the mixt. until the mixt. is uniform as detd. by the nitrite content.

Detoxification of solvent-extracted cottonseed meal. EAGLE, E., AND NORRIS, F. A. Assignor to Swift & Co. U. S. 2,740,718, Apr. 3, 1956; *Chem. Abstr., 50,* 11559e (1956).

Solvent-extd. toxic cottonseed meal and cottonseed pigment glands are made nontoxic by treatment with an aq. soln. of an inorg. alk. salt, such as Na sesquicarbonate, Na carbonate peroxide, NaCl, Na_3PO_4, or NaOCl. Steaming or heating is not necessary unless the pigment glands, which contain the toxic substance, are not freely exposed. Thus, 500 g. of toxic hexane-extd. cottonseed meal was mixed with 250 cc. of 2% Na sesquicarbonate soln. and dried for 6 hrs. in a vacuum oven at 100° and 25 in. Hg. The dried product was ground to pass a 20-mesh screen and incorporated in rat diets at a 67% level. No toxic effects were observed and the animals gained wt. in a normal way.

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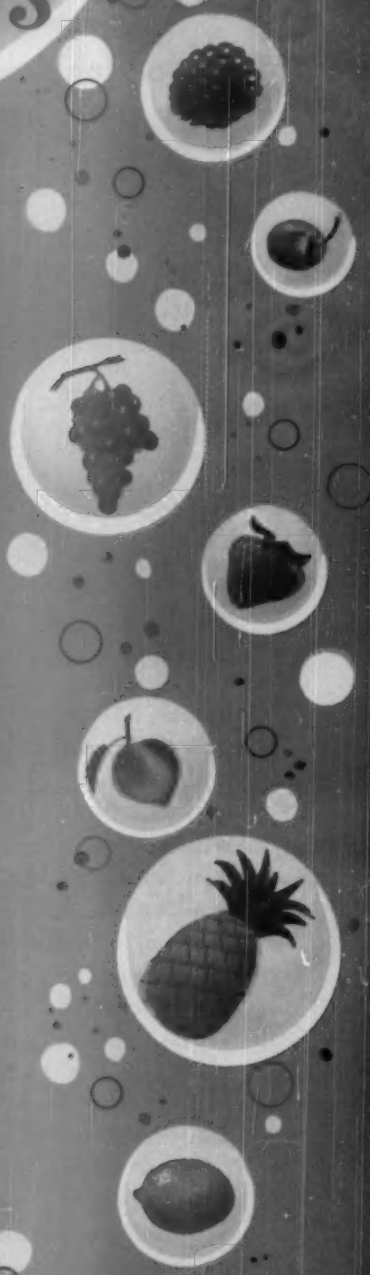

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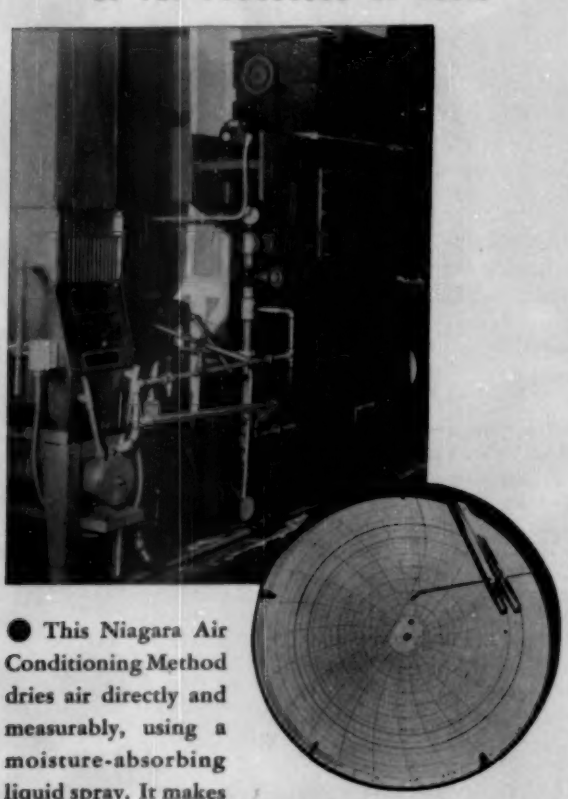

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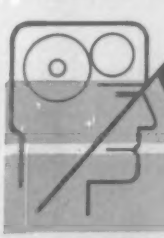

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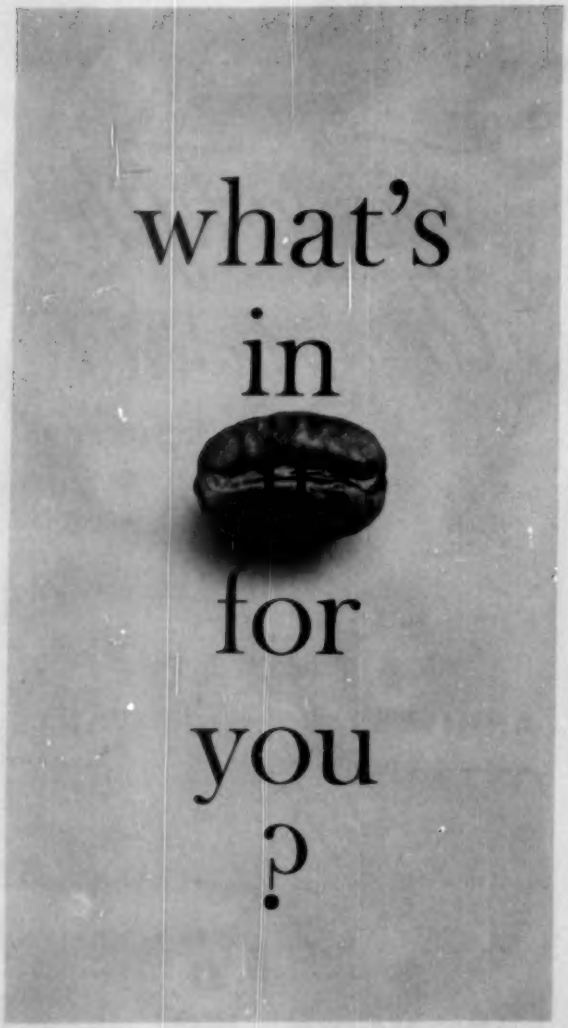

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(Continued from page 44)

Armed Forces, 1819 W. Pershing Rd., Chicago. The courses, at the college level in concept, plan, and type of instruction, include: public speaking conference leadership, report writing, reviewing the literature in scientific fields, statistical design and analysis, electronic instrumentation, and high-speed motion picture photography. Instructors, drawn from among the Institute's technical and administrative personnel, are under the supervision of Dr. Martin S. Peterson, chief of the installation's Scientific Publications and Reports Office. Col John D. Peterman, commandant, and Dr. Donald K. Tressler, scientific director, have over-all charge of the program.

Construction of a new half-million dollar pilot laboratory designed to quadruple the area presently devoted to pilot plant operations was started by Dewey and Almy Chemical Company Division of W. R. Grace & Co., 62 Whittemore Ave., Cambridge 40, Mass. The new laboratory will house equipment and facilities for the storage, distillation, and purification of monomers as well as coagulation and drying facilities. Expected to be in operation on a 24-hour basis by February 1957, the laboratory will be equipped for both emulsion and solvent polymerization as well as having a high-temperature section for polyester, polyamide, and plasticizer research.

. . . *the human element*

Claude L. Alexander has been appointed general sales manager of Sun Tube Corp., Hillside, N. J. Previously, he has held posts at Sun Tube as personnel director of the company, production manager of the Washington, N. J., plant, and assistant to the president.

At the annual Christmas Party of Givaudan-Delawanna, Inc., 330 W. 42nd St., New York 36, N. Y., held on December 15 at the Swiss Chalet, Rochelle Park, N. J., two employees were presented with gold Swiss watches in honor of their 25th anniversary with the company. In the photograph, E. R. Durrer, right, president, makes the presentation to Simon Bigess and Theodor Bumiller, third and fourth from left, respectively, who bring the firm's total of 25-year veterans to 65. Looking on are, from left, H. F. Duffy, treasurer, and Dr. Max Luthy, vice president in charge of Production and Research.

Dr. Melvin W. Aarons has joined the technical staff of Bjorksten Research Laboratories, Inc., Madison, Wis., as senior physicist in the solid state physics section. He was associated previously with Armour Research Foundation and Battelle Memorial Institute. His work with these organizations included direction of research in transistor metallurgy, surface passification problems with germanium and silicon, and properties of crystal imperfections in silicon and certain inorganic explosive crystals. He also is experi-

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enced in electronic paramagnetic absorption and infrared polariscope techniques. Bjorksten also announces appointment to its technical staff of **Robert T. Nagler,** for many years a ballistics and materials control engineer and administrative and technical chief of the ballistics laboratory department of Badger Ordnance Works (Liberty Powder Defense Corp.), Baraboo, Wis.

. . . D&O's IFT'r Bouton

◆ ◆ ◆

John Bouton, formerly chief flavor chemist for Synfleur Scientific Laboratories, has been appointed director of the Flavor Department of Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y. A veteran of 22 years in the industry, Mr. Bouton also has been associated with S. B. Penick Company, and is a member of IFT and of the Society of Flavor Chemists.

◆ ◆ ◆

Geo. D. Mettee of Baltimore recently was presented the Star Club achievement award by the Farm and Home Division, American Cyanamid Company, for his outstanding sales record during 1956. He has been instrumental in establishing Acronize, the food freshness process based on the antibiotic, Aureomycin chlortetracycline, with poultry processors along the eastern seaboard.

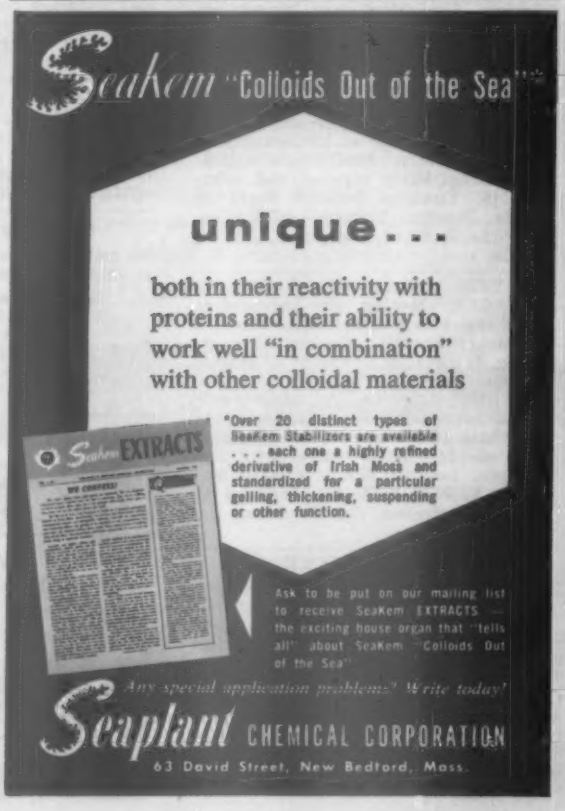
◆ ◆ ◆

. . . Feldberg . . . a career grows in Brooklyn

Charles Feldberg, who recently completed a tour of military duty at the Quartermaster Food and Container Institute for the Armed Forces, Chicago, has been named a technical service representative by Chas. Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn, N. Y. A member of IFT, Mr. Feldberg received his B.S. degree in food technology from the University of Massachusetts. At the QM Institute, he was a technologist in the Plant Products Branch.

◆ ◆ ◆

Appointment of **Seymour H. 'Cy" Evans** as manager of Blue Valley Brokerage, Pittsburgh, Pa., has been announced by Meadow Gold Dairies Food Division. Mr. Evans, manager of Meadow Gold Foods since 1952, will establish his headquarters at North Pole Cold Storage Co., 1222 W. Carson St., Pittsburgh. Blue Valley Brokerage represents the Birds Eye Division of General Foods, LaChoy Chinese Foods, Jiffy Steak Co., Quaker State Food Products, Sol Lenzner Co., Naas Corp., and Cottage Products Division of Joe Lowe Corp. Succeeding Mr. Evans as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manager of Meadow Gold Foods' Carson Street plant in Pittsburgh is **John F. Carolan,** most recently with the company's sales department.

◆ ◆ ◆

. . . Brockway . . . heads Staley research group

Appointment of **Dr. Chas. E. Brockway** as head of a research group has been announced by A. E. Staley Manufacturing Co., Decatur, Ill. Dr. Brockway comes to the Staley Company from the B. F. Goodrich Co., Akron, Ohio, where he has been for 13 years. Staley also announces promotion of **Paul L. Woijeck** to the position of assistant superintendent of its terminal elevators, and of **James Dustin** to the position of superintendent of the materials and methods department.

◆ ◆ ◆

Christopher H. Buckley, recently a national product sales manager for Continental Can Co., has been appointed a sales manager of the Products Division of Kaiser Aluminum & Chemical Corp., 1924 Broadway, Oakland 12, Calif. One of his major responsibilities will be in the field of specialized aluminum containers. His headquarters will be at the British Empire Bldg., 620 Fifth Ave., New York City.

◆ ◆ ◆

Mars, Inc., Chicago, Ill., announces the following personnel changes: **B. A. Bouchard** promoted from general sales manager to vice president and director of sales; **R. K. Chandler** promoted from general superintendent to vice president and director of manufacture; and **H. A. Lehrter** promoted to general advertising manager.

◆ ◆ ◆

In conjunction with the growing demand for its industrial food products, Stein Hall & Co., Inc., 285 Madison Ave., New York 17, N. Y., has assigned **Jack E. Bergwerk** to the Industrial Foods Department where he will assist Gene Finnegan, department manager. Operating from the New York office, Mr. Bergwerk, until recently a general salesman at the firm's Philadelphia branch, will help plan and coordinate the marketing, promotional, and selling efforts for the company's ice cream and food stabilizers, mold- and rope-inhibitor for baked goods, and other industrial food products.

◆

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